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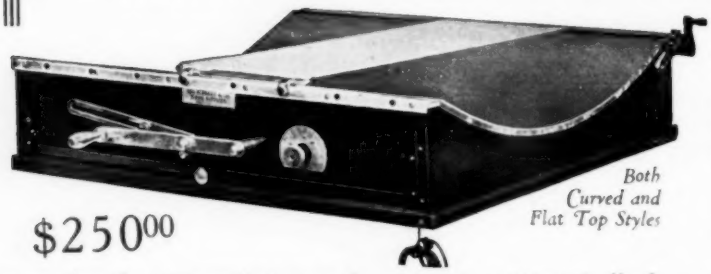

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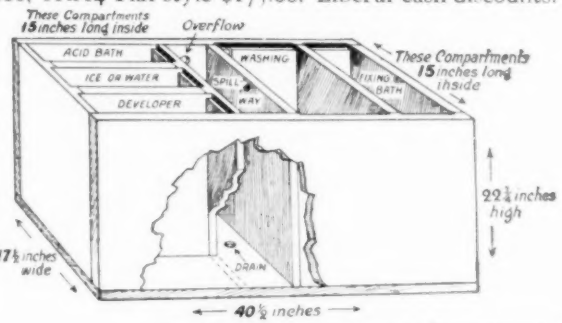

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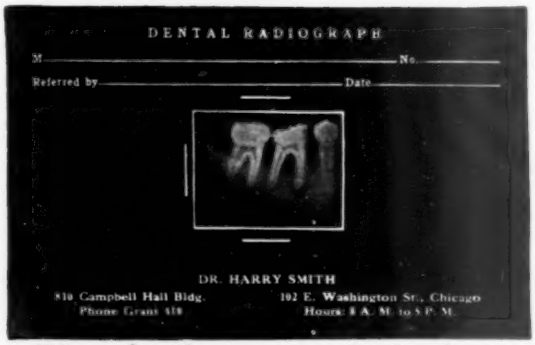

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PHYSOSTIGMINE AS AN AID IN GASTROINTESTINAL ROENTGEN-RAY DIAGNOSIS*

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INTRODUCTION

IN the roentgen examination of the gastrointestinal tract by means of the opaque meal, tonus and peristalsis are of great importance in establishing the site and extent of a pathological process as well as in excluding the presence of a lesion in doubtful cases. A filling defect may apparently be constant in a stomach with absent or sluggish peristalsis and poor tone; with increased tone and active peristalsis, however, the defect may disappear and prove to be of no consequence. Similarly, a filling defect or irregularity of gastric outline may be questionable or uncertain in a stomach with poor tonus and peristalsis, and it may be impossible to determine whether this defect is intrinsic, the result of spasm, or due to pressure from gas in the colon or an extra-gastric mass adjacent to the stomach. In this type of case, peristalsis is probably the most important factor in arriving at a diagnosis. If the lesion is extrinsic or due to spasm, the peristaltic waves will pass through the area in question; whereas if the lesion is intrinsic, the waves will be broken or arrested on reaching the pathological process in the stomach wall.

Spasm of the stomach, pylorus, or duodenum may also be confusing and troublesome in roentgen diagnosis. Spasm alters the tonus, interferes with peristalsis, and causes variations in motility. As is well recognized, spastic deformities may simulate any gastric lesion. Spasm may be due to a lesion in the stomach or duodenum, referred from a lesion elsewhere in the abdomen, or brought on by fear, dislike of the barium meal, and other emotional disturbances.

A drug or mechanical method which would increase tone and peristalsis and eliminate spasm would therefore be of great assistance to the clinician and roentgenologist. Atropine has been used to overcome spasm, but with only partial success. Massage of the abdomen may heighten tonus and increase peristalsis, but the effect is usually fleeting and cannot be obtained in patients with spastic abdominal muscles. Reassurance and the creation of a pleasant emotional state may also be helpful. None of the above methods are uniformly successful in bringing about the desired results.

The problem of finding a chemical agent which heightens tonus, increases peristalsis, and overcomes spasm presented itself to us as important and worthy of

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study. In order to be suitable for the purposes outlined, the drug should have the following characteristics:

1. It should increase or stimulate tonus and peristalsis and overcome spasm.
2. The effect of the drug should be neither fleeting nor too prolonged.
3. It should not cause unpleasant or dangerous side effects.
4. If undesired symptoms or signs occur, an effective antidote should be available.
5. It should be effective by oral administration.
6. The effects of the drug should not interfere too greatly with the routine roentgen study of the gastrointestinal tract.
7. The drug should be stable and easily obtainable.

PLAN AND METHOD OF STUDY

After consideration of the known pharmaco-dynamic effects of the various chemical agents on the alimentary canal, cholin, pituitrin and physostigmine presented themselves as drugs which might conform to the above requirements. Of these drugs, physostigmine appeared most suitable for our purposes and was selected for study for the following reasons: (*a*) Studies on animals indicated that physostigmine increases both tone and peristalsis.[1] Although we did not investigate the effect of pituitrin on the alimentary canal, its pharmacological characteristics suggested that its main action would be to increase tonus without desirable changes in peristalsis. Also, the action of pituitrin varies widely, depending on its source and method of preparation.[2] The main effect of cholin is to increase motility, and studies on patients have shown that it is very variable in its action.[3] (*b*) It has been demonstrated that physostigmine affects the entire gastrointestinal tract in doses that cause no undesirable effects.[4] Following the effective administration of cholin, severe vasomotor reactions are common.[3] (*c*) Undesired side reactions which occur occasionally after physostigmine can be abolished with atropine or hyoscine.[1] (*d*) Observations on animals and patients indicated that the action of moderate doses of physostigmine persists about one to three hours.[1] (*e*) Previous studies[1] suggested that physostigmine was effective after oral administration, while pituitrin is useful only if given intramuscularly and cholin intravenously.

Katsch and Borchers[5] observed the effect of physostigmine on the intestines of cats through an artificial abdominal window. So far as we have been able to ascertain, no roentgenological observations have ever been made of the action of this drug on either the normal animal or human gastrointestinal tract. We planned to use the roentgen-ray method with the opaque meal, as this permits actual observation of the entire alimentary canal.

In our studies on the effect of physostigmine on the gastrointestinal tract, we wished to throw light particularly on the following problems.

1. The behavior of the various portions of the alimentary canal under the effect of physostigmine.
2. The duration of the effect exerted by the drug on the stomach and intestines.
3. The optimum dosage for use as an aid in roentgen diagnosis of lesions of the gastrointestinal tract.
4. Comparison of the effect after oral and subcutaneous administration.
5. The action of the drug in the presence of various pathological conditions involving the gastrointestinal tract.

Our study is based on observations on 4 cats, 3 dogs, and 44 patients. Twenty-four of the patients exhibited no abnormality of the gastrointestinal tract; the others presented various lesions of the stomach and duodenum. The method of study varied somewhat. In some instances, the routine roentgenoscopic studies and roentgen films of the stomach and intestines were made; this procedure was then repeated, under physostigmine, after the lapse of a few days. In others, control observations were made for a period of one-half to one hour, immediately following which the drug was administered and its effects studied. In a few cases, the divided meal method was used. The patients were given a barium meal at six hours and twenty-four hours before the examination; then at the time of observation, the stomach was again filled with barium. This enabled us to visualize the stomach, small bowel and

colon simultaneously, but was unsatisfactory as a rule because of the over-lapping and consequent confusion of the shadows. The observations were repeated at frequent intervals during the first three hours, then less frequently up to six or twelve hours.

OBSERVATIONS

Animal Experiments

Studies were made on 4 cats and 3 dogs. Each of the animals was studied several times on different occasions and under varying experimental conditions. The barium was mixed in milk and the animals permitted to lap the mixture; in some instances it was necessary to hold the animal and give the opaque meal through a tube. Physostigmine salicylate was administered intramuscularly in doses of 0.10–0.50 mg. per kilo of body weight. The first effect of the drug was an increase in the tone of the small bowel. This came on within five to ten minutes and was soon followed by narrowing of the colon with deepening of the haustra. The stomach began to show hypertonicity shortly after the colon. The small bowel became markedly segmented with slow, continuous movement of the barium. Gastric peristalsis began to increase in ten to thirty minutes and became vigorous and deep in practically every animal studied. The heightened tonus and increased peristalsis were at their maximum in from twenty to fifty minutes after administration of the drug and then began to decrease slowly. In several instances, there were periods of a few moments' duration when the entire tract became atonic and peristalsis and the motion in the small bowel ceased; then the tonus increased again, peristalsis became active, and the barium continued its writhing motion in the small bowel. These periodic changes were inconstant in occurrence and duration, and were not present in every case. The duration of the effect varied from fifty minutes to two hours and ten minutes. As the action of the drug disappeared, the stomach returned to normal first, then the colon, and lastly the small intestine. Peristalsis was affected less than tonus, both as regards the intensity and duration of the effect. In all the animals, the stomach emptied rapidly and there was definitely increased motility in both the large and small bowel. One dog, after a dose of 0.5 mg. per kilo of body weight, showed a very marked hypermotility, the barium passing from the stomach to the rectum in fifty minutes. This we attributed to the relatively large dose.

PROTOCOL OF OBSERVATIONS

Cat No. 3. May 12, 1927. Female, black, weight 2.90 kilograms. Animal fed with milk and barium mixtures the day previously; also at 11 A.M. and 6 P.M. today.

6:00 P.M. Stomach large and atonic with practically no peristalsis. Small bowel appears normal; no movement of the barium apparent in the small intestines. Large bowel filled from cecum to middle of descending colon; a few shallow haustra are present in the transverse portion.

6:10 No change.

6:20 No change.

6:30 No change.

6:40 No change.

6:45 0.2 mg. physostigmine salicylate per kilo intramuscularly.

6:47 No change.

6:48 Stomach and colon unchanged. Small bowel somewhat contracted and more tonic.

6:50 Stomach slightly more tonic; no peristalsis. Small bowel more tonic, but shows no motion. Colon narrower in transverse portion; slightly dilated in region of splenic flexure.

6:52 Stomach moderately tonic. Small bowel markedly narrowed, segmented, and the barium is moving slowly. Colon shows many sharp haustra and is very tonic.

6:54 Gastric tonus markedly increased and one deep peristaltic wave is present in the antrum. Small and large bowel as above.

6:56 No change.

7:00 Stomach very hypertonic with three to four slow, deep, peristaltic waves. Small bowel very tonic with slow, continuous movement and much segmentation. Colon very tonic with contracted, sharply defined haustra along its entire extent.

7:06 No change except that the head of the meal has progressed 2 to 3 inches along the descending colon.

7:15 Stomach tonus moderately increased with two deep, slow, peristaltic waves. Small bowel still very much contracted, but movement is slower. Colon unchanged.

7:27 Stomach less tonic and peristalsis now somewhat diminished. Very slight motion in small bowel and colon is slightly less contracted.

7:31 Stomach shows one to two sluggish waves; tonus moderately increased. Both large and small bowel less tonic than at last observation and there is practically no motion of the barium.

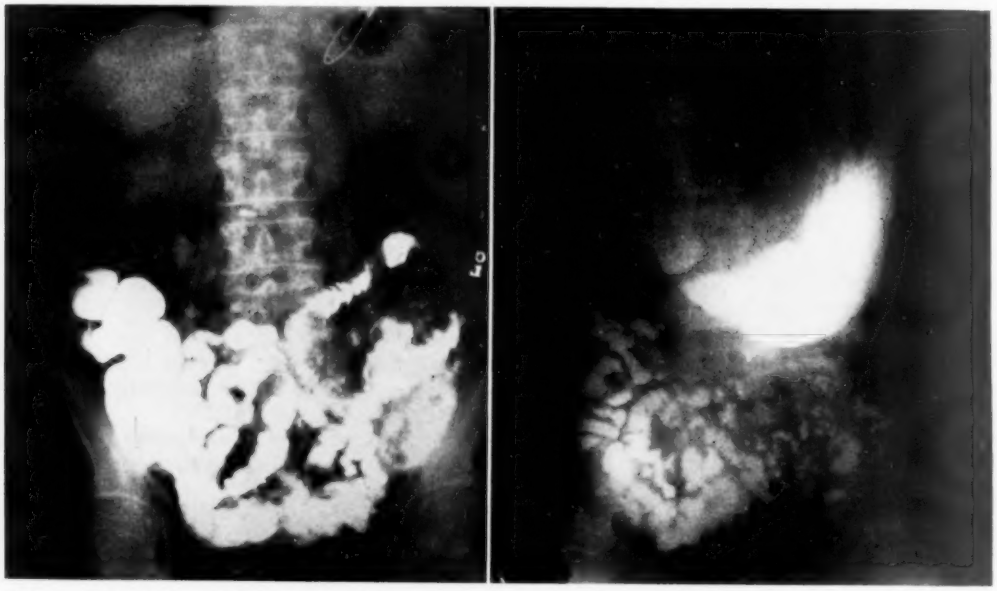

Fig. 1A. Small bowel before administration of physostigmine.

Fig. 1B. After one-fiftieth grain physostigmine. The jejunum and ileum are very contracted, spastic and segmented.

7:45 Peristalsis now sluggish with only one wave visible. Gastric tonus moderately increased. Small bowel still tonic but shows no motion. Colon only slightly tonic.

7:55 Stomach and colon appear normal. Small bowel slightly tonic.

8:00 Entire tract about the same as before drug was given.

8:10 No change.

8:30 No change.

OBSERVATIONS ON MAN

In attempting to determine the optimum dose of physostigmine salicylate for use as an aid in the roentgen-ray study of the gastrointestinal tract, we first administered one-fiftieth grain (1.3 mg.) of physostigmine salicylate. Eight normal subjects received this dosage orally. The effect of the drug was first noted in five to twenty-five minutes after administration, the average time of onset being fifteen minutes. In every instance, the onset of action was evidenced by an increase of tonus. The hypertonicity was apparent in the small bowel for several minutes before any change was apparent elsewhere. Then the colon showed increased tone and lastly, after the lapse of three to ten minutes, the stomach became more tonic. The maximum effect was reached from fifteen to seventy minutes after the drug was administered, at which time there was markedly increased tone over the entire gastrointestinal tract (see Fig. 1, A and B). Peristalsis was affected but little with this dosage. Only 2 of the 8 cases showed an increased peristalsis; this effect was not marked in degree and lasted for only a few minutes. The small intestine was markedly contracted and showed a slow, continuous, worm-like movement of the barium. Numerous areas of segmentation were present, the barium being divided into many small, separate masses. At times, there were areas of

intestine about 2 to 3 inches in length which were dilated, the rest of the visible portion of the small bowel being contracted. In these dilated areas, there was a to and fro motion continuing for a few moments, then narrowing of the lumen set in and the barium moved along toward the colon. In the large intestine the haustral markings were markedly narrowed and very sharp. The lumen of the colon was about two-thirds of its normal size. The motility was slightly increased in 2 of the patients; in the others, the emptying time of the stomach and rate of passage through the small and large bowel was apparently not affected.

The action of the drug invariably wore off first in the stomach. Peristalsis was increased little if at all, and this effect was only of short duration. The gastric hypertonicity disappeared first; then the large bowel and lastly the small bowel returned to normal. The total duration of the effect averaged about one hour and three-quarters. None of the patients complained of unpleasant symptoms. The gastrointestinal tract, after the subsidence of the effect of the drug, was not left in an atonic or "tired out" state, but appeared to be about the same as before the drug was administered.

PROTOCOL OF OBSERVATIONS

April 18, 1927. Male, aged forty-two years, weight 165 lb.

9:15 A.M. Patient given two glasses of barium mixture. Stomach high, transverse, with normal tonus. Peristalsis sluggish with only an occasional wave. Small bowel appears normal.
9:25 No change.
9:35 No change.
9:45 No change.
9:48 One-fiftieth grain (1.3 mg.) physostigmine salicylate orally.
9:50 No change.
9:55 No change.
10:00 Stomach very slightly increased in tone. Small bowel shows definite contraction and increased tonus.
10:05 Stomach tonus increased with two moderately deep peristaltic waves. Small bowel markedly tonic with slow, worm-like motion of the barium.
10:09 As above.
10:14 No change except somewhat more increase in tone of small bowel.
10:20 Stomach hypertonic with one to two moderately deep waves. Small bowel very hypertonic with continuous, slow movement.
10:30 Stomach tonus very slightly increased; peristalsis normal. Small bowel shows no change since last observation.
11:00 Stomach normal in tone and peristalsis. Jejunum shows moderate hypertonicity with very slight movement.
11:20 Both stomach and small bowel normal.
12:00 No change since last observation.
1:15 P.M. Entire meal in ileum, which appears normal.
3:00 Head of meal at cecum. Ileum and cecum appear normal.

April 21, 1927. Male, aged forty-six, weight 146 lb.

Patient had a barium meal twenty-four hours before this examination.

9:00 A.M. Stomach again filled with barium. Stomach of the fish-hook type with normal peristalsis. Jejunum normal. Colon of good tone with shallow haustra.
9:10 No change.
9:20 No change.
9:22 One-fiftieth grain (1.3 mg.) physostigmine salicylate orally.
9:26 No change.
9:30 Stomach unchanged. Small bowel slightly tonic.
9:35 Small bowel definitely more tonic. Colon very slightly narrowed.
9:40 Stomach shows slightly increased tone but no change in peristalsis. Small bowel very hypertonic with continuous, slow movement of barium. Colon moderately tonic with narrowing of the haustra.
9:45 No change.
9:55 Stomach definitely hypertonic. Large and small bowel show definitely increased tone.
10:00 No change.
10:10 Peristalsis normal; gastric tonus still increased. Small bowel very hypertonic with slow, continuous movement. Colon moderately tonic with narrowed haustra.
10:25 As above.
10:40 Stomach normal in tonus and peristalsis. Small bowel as above. Colon moderately tonic.

11:00	Stomach and colon appear normal. Small bowel shows slightly increased tone but no movement.
11:20	Entire tract normal.
12:00 M.	Stomach entirely empty. Large and small bowel appear normal.

A group of 6 patients, who showed no pathological process in the gastrointestinal tract, were studied after the administration of one-twenty-fifth grain (2.6 mg.) physostigmine salicylate orally. The results were, in the main, similar to those previously described. The most striking difference was the increase of peristalsis shown by 5 patients of this group. Within five to fifteen minutes after the onset of the effect of the drug, vigorous peristalsis was present in the stomach. The waves started high in the media and progressed slowly to the pylorus. Two to three waves were present in the stomach at the same time. In some instances the waves were so deep as to bisect the stomach. This vigorous peristalsis, in conjunction with the increased tonus, brought every portion of the stomach and duodenum into very striking relief and made distinct visualization easy (see Fig. 2, A and B). The average duration of the increased peristalsis was about twenty-five minutes. In one patient of this series, there was no visible change in peristalsis.

As in the patients receiving the smaller dose ($\frac{1}{50}$ gr. or 1.3 mg.), the patients of this group also showed increased tonicity as the first effect of the drug. This change was first noted in the small bowel, then in the colon, and lastly in the stomach. The time of onset was five to thirty minutes, the average time being about ten minutes.

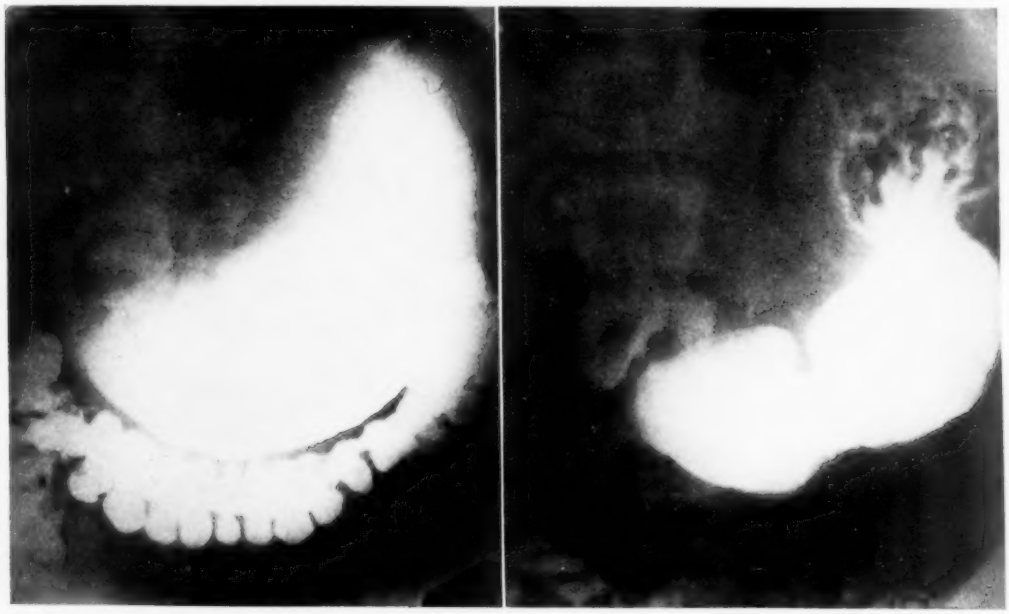

Fig. 2A. Before physostigmine. Stomach is large, atonic, with no peristalsis. The pylorus and duodenum cannot be visualized.

Fig. 2B. After one-twenty-fifth grain physostigmine. The tone is markedly increased. Every portion of the stomach and duodenum are brought into sharp relief.

The duration of the effect was from forty to one hundred and twenty minutes. One patient of this series showed very marked hypermotility, the barium progressing from the stomach to the transverse colon in two hours, the time normally required for this being four to six hours. This hypermotility is, of course, undesirable as it interferes with the routine examination of the small and large bowel. None of the other patients in this group showed any appreciable disturbance of motility. Following the oral administration of one-twenty-fifth grain (2.6 mg.) of physostigmine by mouth none of

the patients complained of unpleasant symptoms.

PROTOCOL OF OBSERVATIONS

May 1, 1927. Male, aged twenty-four, weight 115 lb.

7:50 A.M. Patient allowed to drink two glasses of barium and buttermilk mixture. Stomach of normal tonus with one or two peristaltic waves. No abnormality noted in stomach or duodenum. Stomach empties normally and the small bowel appears normal.

8:00 No change.

8:10 No change.

8:15 No change.

8:20 Physostigmine salicylate one-twenty-fifth grain (2.6 mg.) orally.

8:25 Stomach unchanged. Small bowel slightly more tonic.

8:30 Stomach shows increased tone; peristalsis not affected. Small bowel markedly narrowed and shows definitely increased speed in the movement of the barium.

8:35 Gastric tonus heightened and two to three deep, peristaltic waves are present. The small bowel is very tonic with a slow, continuous movement of the barium.

8:40 As above.

8:50 As above.

9:00 Three slow, deep, peristaltic waves, each of which almost bisects the stomach, are present simultaneously. Stomach and small bowel are very hypertonic. The barium moves along the small intestine with a slow, continuous writhing movement.

9:15 No change.

9:30 Stomach 50 per cent empty; still very hypertonic. Peristalsis is now definitely less active, there being two moderately deep waves present. Small bowel as at last observation.

9:45 No change.

9:50 No change.

10:00 Gastric peristalsis about normal; tonus moderately increased. Small bowel very hypertonic but the movement of the barium is less than at the last observation.

10:15 Stomach shows normal peristalsis with very slight hypertonicity. Small bowel is moderately hypertonic with only slight movement of the barium.

10:30 Stomach normal in tonus and peristalsis. Small bowel shows slightly increased tone with no visible motion.

10:45 Entire tract normal.

11:15 Entire tract normal.

12:00 M. Stomach 80 per cent empty. Head of meal in ascending colon. Entire tract normal.

Four normal patients received one-seventeenth grain (4.0 mg.) of physostigmine salicylate orally. The effect of this dose was greater than in the previous groups. The action began somewhat sooner,

Fig. 3. Hypertonicity and increased peristalsis after the administration of one-seventeenth grain physostigmine orally.

was more marked in degree, and was of longer duration than with doses of one-twenty-fifth grain (2.6 mg.). Peristalsis was very deep and vigorous in 3 of the patients, the fourth showing no change. Gastric tonus was markedly heightened (Fig 3). The small bowel was very contracted with much segmentation. The barium moved through the small intestines with a slow, continuous, writhing motion. The large bowel was markedly contracted

and the haustra were very tight. One patient in this group showed a very marked hypermotility, the barium meal reaching the transverse colon in forty-two minutes and the sigmoid in ninety minutes. This patient was again observed after intervals of five and twenty-four hours, and at both these times the colon was well filled and appeared to be normal in every respect. One of the subjects of this group complained of headache, malaise, dizziness and nausea about two hours after the drug was given; another had slight weakness and cramps.

PROTOCOL OF OBSERVATIONS

May 26, 1927. Male, aged thirty-nine, weight 145 lb.

9:35 A.M.	Two glasses of barium and buttermilk mixture. Stomach of normal tonus with sluggish peristalsis. Duodenum small, regular and fills poorly. Small bowel normal.
9:40	No change.
9:50	No change.
9:55	One-seventeenth grain (4.0 mg.) of physostigmine salicylate orally.
9:57	No change.
10:00	Stomach unchanged. Small bowel slightly more tonic.
10:04	Stomach shows moderately increased tonus with one deep, slow, peristaltic wave which forces the barium through the pylorus and duodenum in quite large amounts. Small bowel very tonic, segmented, with slow, worm-like motion of the opaque mixture.
10:15	Stomach markedly hypertonic with three deep waves. Small bowel as above.
10:20	As above. Head of meal now at cecum.
10:30	Stomach moderately hypertonic with two rather sluggish waves. Small bowel shows no change. Head of meal at hepatic flexure. Colon very tonic.
10:34	Practically no peristalsis. Remainder of tract as at last observation.
10:45	Stomach tonus slightly increased; no peristalsis. Small bowel very tonic; motion somewhat slower. Colon tonic with numerous very sharp haustra.
11:00	Stomach normal in tonus and peristalsis. Small bowel moderately tonic with very slow movement of the barium. Head of the meal at splenic flexure. Colon slightly hypertonic with moderately deep haustra.
11:15	Stomach empty. Small bowel slightly tonic with practically no movement. Colon tonus about normal.
11:30	Small bowel slightly narrowed. Large bowel normal.
12:00	Both small intestine and colon normal.
2:30 P.M.	Small residue in ileum. Head of meal in sigmoid. Small and large bowel normal.
3:30	Barium column has reached rectum. Ileum and colon normal.

THE EFFECT OF SUBCUTANEOUS ADMINISTRATION

In order to compare the results of oral and subcutaneous administration, 2 patients were given one-twenty-fifth grain (2.6 gm.) and one-thirtieth grain (2.2 mg.) respectively subcutaneously. The changes were identical in every respect with those noted after one-twenty-fifth grain (2.6 mg.) orally. We had expected a much more marked effect with the subcutaneous dose, but our observations failed to substantiate this. The patient who received one-twenty-fifth grain (2.6 mg.) complained of cramps, headache, nausea, and profuse sweating about one hour after the injection. These side effects lasted for about one-half hour and were not particularly severe. It was of interest to note that the presence of this undesired reaction did not appear to interfere with the action of the drug on the alimentary canal.

OBSERVATIONS IN THE PRESENCE OF PATHOLOGICAL CONDITIONS OF THE STOMACH

The above observations demonstrate that physostigmine salicylate in non-toxic doses produces marked increase in tonus and peristalsis in the stomach and similar changes in the intestines. Variations in the onset, duration, severity, and type of the reaction were noted in different patients. In general, the effects were comparable and it was felt that the action of the drug would be of assistance in the study of the pathological cases. Observations were made in patients with the following conditions:

A. Marked atonicity of the gastrointestinal tract.

B. Peptic ulcer.

C. Carcinoma of the stomach.

D. Cases with suspected pathology in which the diagnosis was established with the aid of physostigmine.

A. PATIENTS WITH MARKED ATONICITY AND DILATATION OF THE STOMACH

Four patients who had previously been examined roentgenologically showing dilatation and atony of the stomach with sluggish or absent peristalsis were studied after the administration of physostigmine by mouth. Two patients received one-fiftieth grain (1.3 mg.); one, one-twenty-fifth grain (2.6 mg.), and the last, one-seventeenth grain (4.0 mg.). In each instance the stomach became very hypertonic and contracted to normal size or even smaller. The patients who received one-fiftieth grain (1.3 mg.) showed only slightly increased peristalsis; the others developed vigorous peristalsis. In each instance, the action of the drug made distinct visualization of the stomach, sphincter and duodenum possible and ruled out the possibility of any pathological process (see Fig. 4, A and B). This was extremely valuable, as in 2 of the cases there was strong clinical suspicion of carcinoma of the stomach and previous routine roentgen-ray studies had also suggested malignancy because of poor filling in the region of the antrum. All 4 cases showed changes in the small and large bowel similar to those observed in the patients of the first group. None of the patients had any unpleasant symptoms as a result of the drug.

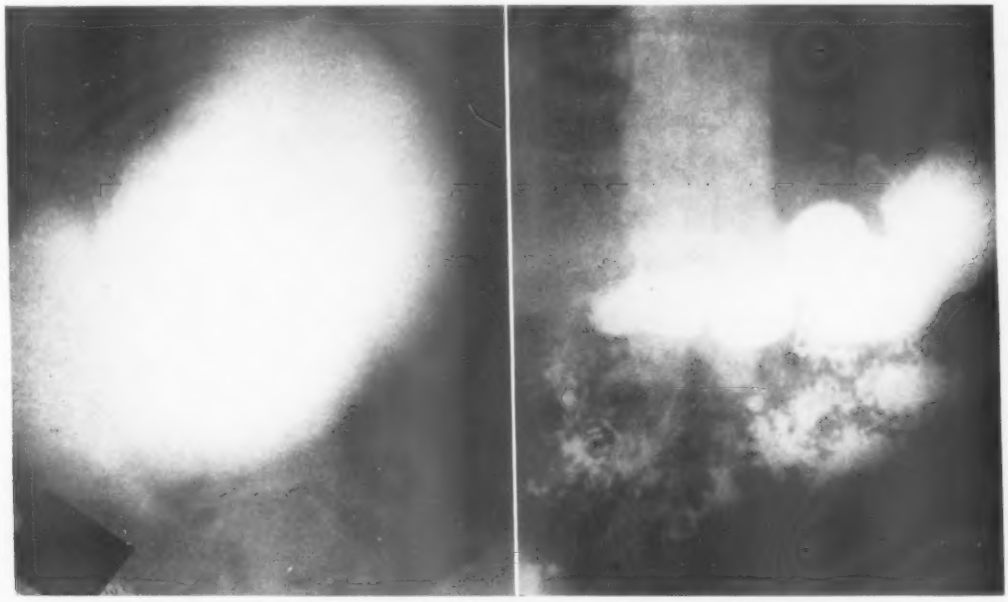

FIG. 4A. Atonic, dilated stomach with absent peristalsis. No filling of pylorus or duodenal cap.

FIG. 4B. After one-fiftieth grain of physostigmine. The stomach is hypertonic and the sphincter and duodenum are distinctly outlined.

B. PATIENTS WITH PEPTIC ULCER

Eight patients with duodenal and 1 with gastric ulcer were studied after the administration of physostigmine. Of these patients, 5 received one-twenty-fifth grain (2.6 mg.) and 4 one-seventeenth grain (4.0 mg.) of the drug by mouth. The changes were in every respect comparable to those described in the previous groups. As ulcer patients are particularly prone to spasm, especially of the pylorus, we had felt that this type of patient would not be suitable for study after physostigmine. Although the drug did appear to increase pylorospasm in the 3 cases in which it was present, the peristalsis induced by

the physostigmine was in each instance strong enough to open the sphincter. As each wave approached the pylorus, the barium was forced out of the stomach and the duodenal outline was very clearly seen. The effects of the physostigmine were, in every case, felt to be of distinct assistance in determining the location and size of the ulcer.

After doses of one-twenty-fifth grain (2.6 mg.) there was no particular disturbance of motility, the stomach emptying in practically the same time as when no drug was used and the rate of passage through the small and large intestines being within normal limits. Two of the patients who received one-seventeenth grain showed a very marked hypermotility. In the first of these, the head of the meal reached the cecum in twenty-five minutes; in thirty-five minutes the head of the barium column was in the middle of the ascending colon; in fifty minutes at the hepatic flexure, and in sixty-five minutes at the splenic flexure. In the second, the barium had reached the ascending colon in twenty-five minutes; in forty-five minutes, the meal had progressed to the middle of the transverse colon and in sixty-five minutes was at the rectum. This patient developed, about one hour after ingesting the drug, cramps, nausea, vomiting, profuse sweating, and weakness. Atropine was given with relief of all symptoms.

C. PATIENTS WITH CARCINOMA OF THE STOMACH

Five patients with carcinoma of the stomach, as shown by clinical and roentgenological evidence, were studied after physostigmine. Each of these patients received one-twenty-fifth grain (2.6 mg.) orally. The functional changes were similar to those described previously. The average time of onset of action of the drug was five to fifteen minutes; the maximum effect was reached in twenty to forty minutes and the action disappeared in from forty minutes to two hours. With the heightened intraventricular pressure and increased peristalsis, the filling defect was very sharply delineated so that its location and extent could be determined more easily and with greater exactness than previously. The drug was felt to be of distinct assistance in confirming the presence of a lesion in every case. No patient of this group had any untoward symptoms.

D. PATIENTS WITH SUSPECTED PATHOLOGY IN WHICH THE DIAGNOSIS WAS ESTABLISHED WITH THE AID OF PHYSOSTIGMINE

Case I. Male, aged fifty-eight, weight 168 lb.

Provisional Clinical Diagnosis. Carcinoma of stomach.

History. During the past eight months, the patient has complained of a dull, heavy ache in the epigastrium coming on ten minutes after meals and lasting about one hour. Occasionally the pain was sharp. He is very frequently nauseated and has vomited three times during the past two months. The vomitus consists of undigested food and brownish fluid. Appetite is only fair. Has lost about fifteen pounds in the past year. Tarry stools noted on several occasions.

The routine roentgen examination of the gastrointestinal tract showed a very marked spasticity of the pylorus with an apparent irregularity of the sphincter and no filling of the duodenum. The stomach was atonic with practically no peristalsis. Manual palpation, examination in various positions, and other maneuvers were unsuccessful in filling the pylorus and duodenal cap. There was about 20 per cent gastric residue at the six-hour examination.

The examination was repeated after atropine with unsatisfactory results. The pylorus did not appear to open at any time during a prolonged roentgenoscopic study so that the sphincter and duodenum did not fill and could not be properly visualized. There was, also, about 15 per cent gastric stasis after six hours.

After physostigmine salicylate, one-twenty-fifth grain (2.6 mg.) orally, deep, vigorous peristalsis and increased tonus resulted. As each peristaltic wave approached the pylorus, the sphincter opened and the duodenum filled. This made possible very distinct and clear visualization of the pylorus and duodenal cap and the pathological process present was definitely shown to be an ulcer of the first portion of the duodenum (see Fig. 5, A and B). The stomach was completely empty at the end of six hours.

Case II. Male, aged nineteen, weight 140 lb.

Provisional Clinical Diagnosis. Question of appendicitis or duodenal ulcer.

History. During the past year, the patient has had frequent attacks of pain in the epigastrium and right lower quadrant. Each attack

continues for two to three weeks and the patient is then entirely free from pain or distress for about two months. The epigastric pain comes on about one hour after meals and is relieved by food or alkali. The pain in the right lower quadrant is irregular, having no relation to meals and showing no definite association with the epigastric pain. There has been no loss of weight, nausea or vomiting. The patient is very constipated, but has noted no tarry stools.

The routine roentgen-ray studies showed a marked pylorospasm with an irregularity of the duodenum. The duodenal deformity was not typical of ulcer, however, and it was thought that it might be due to spasm. The appendix was long, kinked, not movable, and there was localized tenderness over it on roentgenoscopic palpation. In view of these findings, it was thought that the pylorospasm and duodenal deformity might be due to referred spasm from the appendix.

After one-twenty-fifth grain (2.6 mg.) of physostigmine salicylate orally, the heightened tonus and increased peristalsis overcame the pylorospasm, making distinct visualization of the sphincter and duodenum possible. The duodenal cap was shown to be definitely irregular with a typical ulcer deformity and a definite diagnosis of ulcer was made. At operation, the patient was found to have a duodenal ulcer with also a low grade, inflammatory process in the appendix.

Case III. Male, aged forty-five, weight 180 lb.

Provisional Clinical Diagnosis. Probable peptic ulcer.

History. For the past three months, the patient has suffered from a dull, non-radiating pain in the epigastrium. The pain usually comes on shortly after meals, although at times it has been present between meals. Food and alkali give no relief. There has been marked constipation with a poor appetite and loss of about 25 pounds in the past three months; also nausea but no vomiting. No tarry stools were noted.

The roentgen-ray examination showed an incisura in the prepyloric region with irregularity of the duodenum. There was marked pylorospasm. Peristalsis was sluggish and the stomach was of rather poor tone. The prepyloric defect was constant in all positions and did not change on manual pressure. The peristaltic waves did not appear to pass through the incisura, although the waves were so sluggish that this could not be determined with certainty. There was about 15 per cent gastric residue at the six-hour examination.

At the re-examination, after the oral administration of one-twenty-fifth grain (2.6 mg.) of physostigmine salicylate the peristaltic waves were seen to pass directly through the incisura-like defect in the stomach, which was proven to be a spastic deformity, rather than due to an intrinsic gastric lesion. The duodenum also filled well and was seen to be perfectly regular in outline. This case illustrates the value of physostigmine in ruling out the presence of a lesion in doubtful cases.

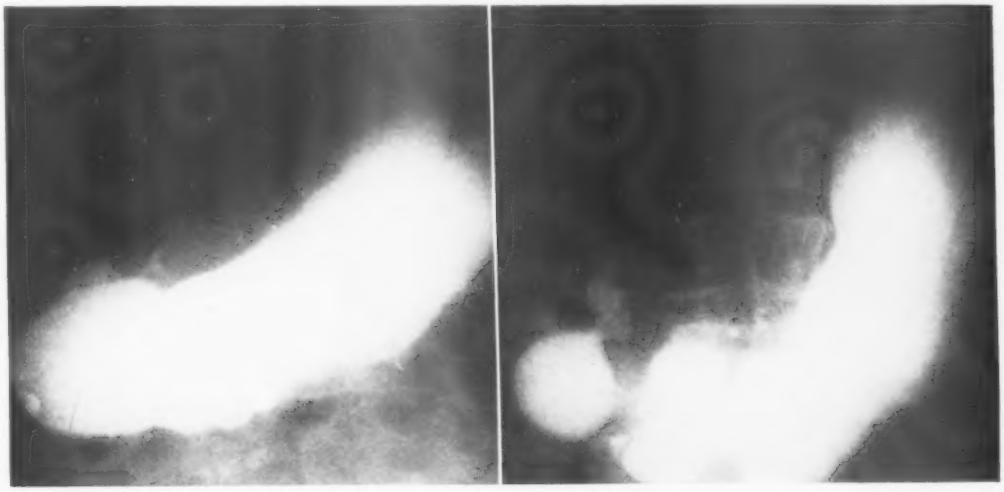

Fig. 5A. Before physostigmine. Stomach atonic with no peristalsis. Marked spasm of pylorus making it impossible to fill sphincter or duodenum. After atropine, the picture was practically unchanged.

Fig. 5B. After one-twenty-fifth grain physostigmine. The heightened tonus and increased peristalsis open the pylorus and fill the duodenum. The deformity of the duodenal cap is clearly shown.

CASE IV. Female, aged fifty-two, weight 130 lb.

Provisional Clinical Diagnosis. Question of carcinoma of stomach.

History. During the past six weeks, the patient has had a gnawing, intermittent pain in the region of the umbilicus. This pain is slight, comes on usually two hours after eating, and does not radiate. There has been frequent nausea with vomiting of much dark material on several occasions. She has lost about 20 pounds in this time. No tarry stools have ever been noted.

FIG. 6A. Before physostigmine. Poor filling of antrum and pylorus, suggestive of carcinoma.

The roentgen-ray examination of the gastro-intestinal tract showed a large, dilated, atonic stomach with no peristalsis. There was evidently retained secretion and food in the stomach, as the ingested barium mixture appeared to be markedly diluted and cast a much fainter shadow than usual. The antrum and pylorus did not fill well, but it was impossible to distinctly visualize any irregularity of gastric contour. There was about 50 per cent gastric residue at the six-hour examination and at twenty-four hours there was still about 15 per cent retention in the stomach. It was felt that the patient had a carcinoma of the stomach, but the extent of the lesion, as well as its exact location, were obscure.

The patient was given one-twenty-fifth grain (2.6 mg.) of physostigmine salicylate by mouth. The effect of the drug was a contraction of the stomach with markedly increased tonus. These changes brought the margins of the stomach into very striking relief and a large filling defect involving both the greater and lesser curvature sides of the antrum was very sharply delineated (see Fig. 6, A and B). It could be very clearly seen that the lesion had extended along the lesser

FIG. 6B. After one-twenty-fifth grain physostigmine. The irregularity and filling defect involving the pre-pyloric region are sharply outlined. The lesion is demonstrated to be carcinoma, probably inoperable.

curvature for a considerable distance and was hopelessly inoperable.

CASE V. Male, aged fifty-five, weight 140 lb.

Provisional Clinical Diagnosis. Gallstones; adhesions; question of carcinoma of the stomach.

History. For years the patient had had attacks of pain in the upper abdomen and had been operated on twice for gallstones. After the second operation, he continued to have severe pain in the epigastrium. The pain radiated to the back and there was nausea and vomiting during the attacks.

Four roentgen examinations of the gastro-intestinal tract were made by different roentgenologists and each showed a constant filling defect involving the greater curvature side of the stomach in the pre-pyloric region. Although

the two previous operations had revealed no evidence of malignancy, the persistence of the filling defect caused uneasiness.

Physostigmine salicylate one-sixtieth grain (1.0 mg.) was injected and the roentgen examination repeated. Within five minutes after the injection, gastric tonus was markedly increased and there was deep, vigorous peristalsis. The filling defect disappeared and the peristaltic waves passed without a break through the site of the defect, proving that there was no lesion in the stomach wall.

These and several similar cases not included because of lack of space illustrate the value of physostigmine as an aid in cases in which the routine roentgen studies were inadequate to make a definite diagnosis. In the first two patients, the use of physostigmine established definitely the presence of a duodenal ulcer. In the third case, the drug made it possible to rule out the presence of a lesion in a patient who appeared to show a pathological process. Case IV illustrates the value of physostigmine in locating the site and establishing the extent of a pathological process. In this instance, the drug showed that the lesion was inoperable and saved the patient an exploratory laparotomy. In Case V, a filling defect had been constantly present at four examinations, each made at a different clinic, and it was feared that the patient had a carcinoma of the stomach. The administration of physostigmine abolished the defect and showed that it was due to spasm rather than an intrinsic gastric lesion.

DISCUSSION

The observations presented demonstrate that physostigmine is a valuable agent for increasing peristalsis, heightening the tonus of the alimentary canal, and overcoming spasm of the stomach. The drug is, therefore, of great assistance to the roentgenologist in establishing the site and extent of a pathological process and also in excluding the presence of a lesion in doubtful cases. It is a new and important aid in the roentgen examination of the gastrointestinal tract.

The desired results may be produced without dangerous toxic manifestations and in atropine we have an antidote which offsets any untoward symptoms which occasionally develop. The effects of the drug are practically the same after oral and subcutaneous administration. This finding is of great practical importance. If the drug were effective only when given subcutaneously or intravenously, its use as a diagnostic aid would be distinctly limited. Physostigmine, however, produces the desired results when administered orally and can be used without special preparation or effort.

The optimum dose appears to be one-twenty-fifth grain (2.6 mg.) orally. With one-fiftieth grain (1.3 mg.), there is increased tonus, but peristaltic changes are slight and inconstant. After doses of one-seventeenth grain (4.0 mg.), the action on both tone and peristalsis is usually striking and prolonged. However, this dosage is apt to induce untoward symptoms and may cause hypermotility, thereby interfering with the routine roentgen examination of the gastrointestinal tract. One-twenty-fifth grain may be given to the average patient with reasonable assurance that the desired effects will be produced and that there will be no untoward reactions or interference with the routine roentgen studies of the alimentary canal. In cases in which the first dose of physostigmine has been ineffective or given too slight an effect, the dose may safely be repeated. It is advisable to wait at least one-half hour before administering the second dose. In all cases given this double dosage, atropine should be easily available so that it may be used without delay if indications arise.

As physostigmine acts on the autonomic nervous system, considerable variation in the dosage and the individual reaction is to be expected. It has been shown[4] that the effective dose of this drug varies from patient to patient. In the majority of cases, the dose required was much higher than that recommended by the U. S. Pharmacopoeia. These observations also showed that normal subjects develop systemic reactions after much smaller doses than do patients with abdominal distention. Comparison of the minimal toxic dose during and after distention indicates that the same patient, after recovery, is more susceptible to the action of physostig-

mine than during the height of the disease. The changes in the susceptibility of the autonomic nervous system during the various functional and pathological states will be discussed at length in a subsequent communication.

A very important point in the use of physostigmine is that after the subsidence of the effects of the drug, the gastrointestinal tract returns to apparently the same condition as before the drug was given. Therefore we are not left with an atonic or "tired-out" alimentary canal after the administration of physostigmine.

The action of the drug is apparent first in the small bowel, then in the colon, and lastly in the stomach. The tonus is increased in every instance. Peristaltic changes are less marked both as regards intensity and duration and in a few instances there appears to be no appreciable increase of peristalsis even after large doses. The effects were produced experimentally in cats and dogs and also in humans. Patients with peptic ulcer, carcinoma of the stomach, and marked atonicity were studied and the drug was of great assistance in showing the site and extent of the lesion. In several doubtful cases, the drug was a valuable aid in ruling out the presence of a pathological process.

Toxic manifestations occasionally occur, although in none of our patients were these of sufficient severity to cause alarm. Weakness and headache are the earliest complaints. Sweating, cramps, nausea and vomiting are also early symptoms. Severe vomiting, abdominal pain and collapse are symptoms of marked intoxication. Atropine offsets all toxic manifestations rapidly and effectively. With mild reactions, the atropine may be given orally ($\frac{1}{150}$–$\frac{1}{50}$ grain). If there is marked nausea or vomiting, subcutaneous administration of the antidote is essential, as it has been shown[6] that in the presence of these symptoms the absorption of the drug given orally is delayed.

The contraindications to the use of physostigmine are the presence of an inflammatory process such as appendicitis or peritonitis, severe cardiac disease, pregnancy, and intestinal obstruction. None of our patients showed an idiosyncrasy to physostigmine and our studies show that the use of this drug as a diagnostic aid need not be attended with unpleasant or dangerous reactions.

CONCLUSIONS

Physostigmine increases peristalsis, heightens the tonus of the gastrointestinal tract and overcomes spasm. These effects can be produced with doses which are non-toxic, and in atropine we have an effective antidote for the toxic symptoms which may occasionally develop.

The drug is equally effective after oral and subcutaneous administration.

Physostigmine may be used as a diagnostic aid without interference with the routine roentgen-ray studies of the alimentary canal.

The action of physostigmine is often of great assistance in establishing the site and extent of a pathological process, and also in ruling out the presence of a lesion in doubtful cases.

The optimum dose for use as an aid in roentgen diagnosis of lesions of the gastrointestinal tract is one-twenty-fifth grain (2.6 mg.) orally. This dosage gives an effect sufficiently prolonged to permit of adequate roentgenoscopy and the making of roentgenograms.

We wish to express our sincere thanks to Dr. P. F. Butler, director of the X-ray Department of the Boston City Hospital, for his kind assistance and helpful suggestions.

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SILICOSIS AS AN INDUSTRIAL HAZARD IN ONTARIO GOLD MINING*

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PROBABLY the most extensive survey on the North American Continent along the lines of pneumoconioses was completed in the year April 1, 1926 to April 1, 1927 on silicosis in the Porcupine Gold Mining Camp of Northern Ontario.

This survey was made under the auspices of the Mine Operators of the Porcupine group of mines in compliance with the amendment to the Miner's Phthisis Act of April 8, 1926, bringing silicosis under the status of a compensable industrial disease.

At this point it might be advisable to define "miner's phthisis" and "silicosis" as used in the medicolegal sense. The term "miner's phthisis" is used to describe a definite pulmonary disease due to occupational conditions (in this case metal mining). "Silicosis" is the pathological condition necessary for an individual case to be classified as "miner's phthisis." It is then evident that a man suffering from tuberculosis *without silicosis* is *not* a case of "miner's phthisis."

Approximately 4000 miners have been examined and catalogued as to nationality, age, height, weight, history of underground exposure to silica dust, history of surface exposure to silica dust (crushers, etc.), family and personal history, present complaints and duration of same, chest expansion, vital capacity, heart contours, physical signs, sputum analyses, and temperature records. A careful study of 14 × 17 stereo-roentgenograms of each chest was made and recorded.

Ninety-four claims were submitted for compensation. Each claimant was tested in order to determine if the silicotic condition had produced any incapacitation for work. Exhaustive clinical examinations were correlated with roentgenographic findings and classifications established. The general trend of thought in similar work done by the Miner's Phthisis Bureau of South Africa was adhered to as a precedental standard to follow. Hence the South African Classification of Ante-primary, Primary, and Secondary stages was adopted as an arbitrary standard for awarding compensation.

It must be known, however, that these standards do not fit exactly as to clinical stages since one step merges into the next by a series of clinical as well as roentgenological advances.

However, sufficient definite evidence of each stage is clearly outlined in the classification below to form the basis whereby a clinical stage is placed in one of the standard legal types for purposes of compensation claim adjustment.

SILICOSIS CLASSIFICATION—SOUTH AFRICAN STANDARDS

The average normal chest	N.	Normal.
	M.F.U.	More fibrosis than usual.
	M.F. +	More fibrosis plus.
	M. to C.	More to commencing fibrosis.
Ante-primary	C.F.	Commencing fibrosis.
	C.F. +	Commencing fibrosis plus.
	C. to E.	Commencing to early fibrosis.
Primary	E.F.	Early fibrosis.
	E. to M.F.	Early to medium fibrosis.
	M.F.	Medium fibrosis.
Secondary	M. to A.	Medium to advanced fibrosis
	A.F.	Advanced fibrosis.

From the above classification and by comparison of illustrations submitted it is seen that a normal and exceptionally clear chest roentgenographically, together with others of "slightly more fibrosis than usual," and those of even more advanced fibrosis, are all classed as average normal chests (see Plate 1, Figs. 1, 2 and 3).

It must be borne in mind before going on to the Ante-primary Stage that although silicosis means fibrosis, the converse is not always true and all fibrosis is by no means due to silica only. Here again we should also make mention of our appreciation that intercurrent infections and upper respiratory diseases aid in the formation of some of the existing pulmonary fibrosis.

In referring back to the South African classification it will be seen that the Ante-primary Stage has three subgroup-

*The writers' thanks are due to Mr. Charles M. Omerod of the local staff for information regarding underground dust conditions including quantity and character of the dusts found.

ings, the Primary Stage four, and the Secondary Stage two divisions, in so far as simple, uncomplicated, silicotic fibrosis is concerned. However, when a tubercle is superimposed, or spontaneously develops, in an established silicotic lesion, no matter what stage, early or late, in which the case has been categorized already, it straightway goes up to the Secondary Stage.

Invariably a well-established silicosis with a suspicion of tuberculous involvement will show tubercle bacilli if sufficient sputum analyses are done. In fact it is mooted that all secondary silicoses have a latent tubercle factor that cannot be outruled despite the fact that years may elapse before actual breakdown of lung tissue takes place. Experience, too, has proven that a tubercle superimposed on silicosis has a grave prognosis, while uncomplicated silicosis, aside from the mechanical restriction of lung function (due to chest rigidity and loss of alveolar resiliency) is of secondary significance.

It might be well to mention at this stage that we feel that the fibrosis shown in miners' lungs of this camp is in some measure produced by silicates and rock dusts other than silica, and would compare more closely with the conditions as found in Australia at Broken Hill mines rather than with the truer, sharply-outlined silicosis of South Africa.

There is also a type of silicosis common to tin and iron miners which has a peculiar appearance all of its own. It seldom reaches past the Primary Stage due to its long "incubation period." It is usually produced only after very long underground exposure and is probably partly due to silicates and rock dusts other than free-silica. The appearance of the roentgenogram suggests a very minute "pea-meal" mottling throughout the lung substance supported in a fine linear reticulum and network. These nodules or mottlings are more distinct in individual outline, are extremely fine in size, and do not tend to coalesce as do the typical soft outline shadows of free-silica formation. We have had several excellent examples of this type of miner's phthisis among applicants from England who have had over twenty years' exposure to dust in tin and iron mines.

In the accompanying roentgenograms an attempt is made to show typical roentgenographical examples of each type and stage of silicosis. The intermediate transitional stages, however, are not being attempted in view of the fact that reproductions of such fine degrees of linear markings and mottlings are lost in the transpositions following reductions of the original film. We trust that the ones submitted will be sufficiently clear to demonstate our conclusions.

For purposes of comparison two particularly clear chests are presented as a basis of the normal chest (see Plate 1, Figs. 1 and 2). These show a minimum of hilic shadows and only slight linear markings scarcely extending out further than the mid-lung fields. Probably less than a dozen men presented chests with so few linear markings as to be regarded as typically normal and really ideal chests. It will be seen that the vast majority show varying degrees of fibrotic changes and some to such a degree that one is prone to prejudice one's self in favor of a long history of underground exposure, when in reality the man has not been underground

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Plate 1. Figs. 1 and 2. Normal chests. Fig. 3. A "more fibrosis plus." Just a stage below ante-primary. Figs. 4, 5 and 6. Definite ante-primaries. Figs. 7, 8 and 9. Primaries.

Fig. 1. Case 2556. Swede, aged twenty-three. Nineteen months underground. Normal chest.

Fig. 2. Case 2545. Italian, aged twenty-nine. Six years underground. Normal chest.

Fig. 3. Case 2355. Austrian, aged forty. Seven years underground. A "more fibrosis plus." Just less than ante-primary.

Fig. 4. Case 3151. Englishman, aged forty-two. Twenty years tin mining in England; four and a half Ontario mining. Ante-primary.

Fig. 5. Case 2607. Englishman, aged fifty-one. Twenty-two years coal; six years copper, England; three and a half years, Ontario. Ante-primary.

Fig. 6. Case 3304. Englishman, aged thirty-four. Nine years iron-ore England; three years Ontario. Ante-primary.

Fig. 7. Case 235. Italian, aged thirty-seven. Eleven years in Ontario. Primary.

Fig. 8. Case 1492. German, aged forty. Eight years Ontario mining. Primary.

Fig. 9. Case 2440. Austrian, aged thirty-seven. Ten years in Ontario. Primary.

PLATE I

FIG. 1.

FIG. 2.

FIG. 3.

FIG. 4.

FIG. 5.

FIG. 6.

FIG. 7.

FIG. 8.

FIG. 9.

(For legends of Plate I, Figures 1 to 9, see page 316.)

at all, nor even engaged in a former dusty occupation. Thus the habitus alone of the individual often accounts for his poor pulmonary showing. There is also a racial predisposition in some cases and it has been shown that certain types of Portugese, Montenegrins, Greeks, Italians and others are poor risks for free-silica mines. Similarly the tuberculous predisposition of the Finns, Irish, Italians, Newfoundlanders and others make them a potential hazard if the slightest evidence of tuberculosis is shown.

THE ANTE-PRIMARY STAGE

In the Ante-primary Stage the linear markings may not be so pronounced as in many cases of "more fibrosis than usual," but the parenchymal tissue supports fine, fluffy, isolated mottlings, about the size of a pin or match-head. These are not to be confused in any way with the floating "cigarette smoke" picture of incipient tuberculosis. Almost invariably the latter is found close to the periphery and with fan-like radiations from the hila outwards following the line of lymph drainage from the inflammatory process as shown by the latter's indistinct haziness and localization. The silica, on the other hand, appears more concrete in its evidence, and suggests "mass in minute distribution;" a true fibrosis scattered frequently heterogeneously throughout the lungs but still retaining more or less homogeneous groupings.

The apparent site of predilection is outward from the lower bronchi and immediately beneath the pectoral muscles, so that undue adiposity or over-development of the pectorals frequently masks the site of the earliest manifestation of silica organization. Next in order the lower portions of the upper lobes of each lung are usually involved bilaterally. Here, too, is the site in later stages of the frequent massive-pleuritis occurrence.

PRIMARY SILICOSIS

The Primary Stage of silicosis, in early appearance, is an exaggeration of the well-established, minute or large snowflake appearance, without mass formation, but with a beginning coalescence of the snowflake mottling into clusters, and scattered in "snowstorm" appearance throughout the lungs.

This is the typical picture, but it is often disguised by other diseases superimposed or coexistent, such as tuberculosis, syphilis, bronchiectasis, bronchial asthma, etc., into very incongruous irregularities from the simple and pure picture of uncomplicated primary silicosis. It is the recognition or discovery of these secondary factors that debars "snap-diagnosis" from the film and makes classification of silicosis more difficult. However, to anyone skilled in chest examination and roentgenological interpretation, and with a memory filled with past experiences to bear out one's viewpoint, fitting each case into its proper category becomes a relatively simple matter.

On the other hand, whereas the roentgenograms show the relative amounts of silica deposit and its typical fibrotic, chemico-protoplasmic distribution throughout the lungs, yet these examples are set apart as a roentgenological comparison standard, and not necessarily a compensation standard. Some cases having slight roentgenographical evidences show marked

Plate II. Figs. 1 to 9. All secondary silicoses. This group is invariably complicated with tuberculosis. Figs. 4, 6, 8 and 9 are of cases showing positive tubercle bacilli. The organism has not been demonstrated in the balance of the group to date.

Fig. 1. Case 689. Roumanian, aged thirty-nine. Thirteen years Ontario. Secondary.

Fig. 2. Case 2946. Scotchman, aged fifty-five. Twenty years in British Columbia and Ontario. Approximately seven years in Ontario. Secondary.

Fig. 3. Case 224. Lithuanian, aged forty-two. Fifteen years in Ontario. Secondary.

Fig. 4. Case 3067. Austrian, aged fifty-four. Five years in Ontario. Positive sputum. Secondary.

Fig. 5. Case 640. Ukranian, aged thirty-eight. Eighteen years in Ontario. Secondary.

Fig. 6. Case 3345. Finlander, aged forty-four. Four years in Ontario. Positive sputum. Secondary.

Fig. 7. Case 433. German-Polander, aged forty. Twelve years in Ontario. Secondary.

Fig. 8. Case 88. Irishman, aged seventy-one. Eight years in Ontario. Former work not recorded. Positive sputum. Secondary.

Fig. 9. Case 3065. Jugoslavakian, aged thirty-eight. Twelve years in Ontario. Positive sputum. Secondary. This case is also shown in Plate III as tuberculous. It is shown as secondary silicosis in this plate because it is impossible to rule out the probability of silica having been an early factor in augmenting the disease.

PLATE II

FIG. 1.

FIG. 2.

FIG. 3.

FIG. 4.

FIG. 5.

FIG. 6.

FIG. 7.

FIG. 8.

FIG. 9.

(For legends of Plate II, Figures 1 to 9, see page 318.)

physiological effects and would be partially physically incapacitated for work. Others showing gross infiltration and a typical Advanced Primary silicosis, or even a Secondary Stage roentgenogram would, on account of physical fitness, be no further advanced than a definite Ante-primary or Early Primary Stage, for purposes of compensation. Hence we see that the film alone enters into a diagnosis only in so far as a roentgenogram should, namely, to cite a roentgenological conclusion, which in conjunction with an accurate history, and an adequate physical examination, together make up a diagnosis. Credit must be given to the consistent evidence of the film if the technique is maintained at a high standard.

SECONDARY SILICOSIS

In describing the secondary uncomplicated silicotic, of which type we have only one outstanding example (Fig. 1, Plate II), it will be noted that the distribution of the fibrotic areas is relatively uniform from apex to base. The fine, soft, irregular mottlings fading off at their edges are each about the size of a pea, and vary slightly in respective density from part to part of the lung, with some showing faint fibrosis, and others an almost calcification density. A secondary silicosis might give one the impression of a miliary tuberculosis whose fine mottling had suddenly become disrupted, greatly exaggerated, and disseminated throughout the whole lung, and fibrosed at once. The differential diagnosis is quite simple in view of the fact that were the condition tuberculous instead of silicotic, the physical findings and symptoms would be out of all proportion to the relatively negative findings in silicosis uncomplicated.

The Complicated Secondaries are quite varied and are the greatest problem in classification. The reason for this is obvious since these cases are considered total, permanent, disabilities. Before a claimant is placed in this category he is well tested for ability to work, sputum analyses repeatedly done, and general history of exposure checked. All this is done to justify the total disability award that amounts to a considerable sum when considered over a period of years, the "life-expectancy" of the injured workman. This period may vary from a few months to several years depending on whether the tubercle bacillus is present, its virulence, the resistance of the host, together with the general decompensation changes due to silicotic effects on the vital organs such as the liver, kidneys, spleen, etc., as well as the increased metabolic changes due to the toxins of active tubercle bacilli.

STATISTICAL DATA OF SILICOSIS AND TUBERCULOSIS

Out of a total of 94 cases submitted for compensation there were found:

Ante-primaries	39
Primaries	28
Secondaries	27
Total of	94

INCIDENCE OF TUBERCULOSIS FACTOR IN 4000 EXAMINATIONS

Applicants showing positive sputum	1
showing a definite risk	22
showing a slight risk	13
Apparently non-significant peribronchial tuberculosis	38
Total of	74
Employees showing positive sputum	10
showing a definite risk	67
showing a slight risk	118
Apparently non-significant peribronchial tuberculosis	52
Total of	247
Grand total of	321

PLATE III. Shows cases of tuberculosis in which silica cannot be demonstrated as being present. It will be particularly interesting to note that the amount of pulmonary change is much less than shown in Plate II where silica is a complicating coincidental factor. A comparison of these two plates demonstrates clearly the seriousness of the two conditions simultaneously in the same affected miner.

FIGS. 1 and 3. Show increased hilic and linear markings with studding out into the parenchyma of healed tuberculous nodules.

FIG. 2. A longstanding chronic fibrous phthisis with marked fibrosis and calcification of parenchymal shadows. "Closed tuberculosis."

FIG. 4. Shows left upper parenchymal lesion with pleural thickening out toward periphery.

FIG. 5. A condition similar to Figure 4 but more pronounced.

FIG. 6. An upper right-sided lesion. This patient died three months after admission to a sanatorium, from a rapidly progressing tuberculosis.

FIG. 7. A case of bilateral active tuberculosis.

FIG. 8. Extensive left-sided tuberculosis with large cavity in left upper lobe.

FIG. 9. This is the same case as in Figure 9, Plate II, and shows extensive spontaneous pneumothorax.

PLATE III

FIG. 1.

FIG. 2.

FIG. 3.

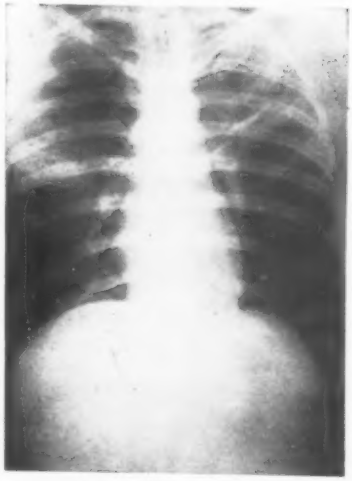

FIG. 4.

FIG. 5.

FIG. 6.

FIG. 7.

FIG. 8.

FIG. 9.

(For legends of Plate III, Figures 1 to 9, see page 320.)

These data do not include the Primary or Secondary silicoses which are invariably tuberculous.

SUMMARY

1. The local incidence of silicosis is low in comparison with the Rand of South Africa.

2. The pulmonary condition, as roentgenographed, presents here a picture with contrastingly softer shadows than those from South Africa.

3. "The condition is of much less serious nature and would seem to be caused by rock dust (*a*) other than silica, (*b*) containing a small percentage of siliceous dust mixed with that from silicates and other accessory minerals" (C. M. Omerod).

4. Tuberculosis is the predominating serious factor but does not exist to nearly the same extent or virulence as that of South Africa.

CONGENITAL ABSENCE OF THE CLAVICLES (HEREDITARY CLEIDOCRANIAL DYSTOSIS*)

REPORT OF CASE

BY H. C. PILLSBURY, M.D.

Lieutenant Colonel, Medical Corps

U. S. ARMY

THIS condition was first reported by Stahmann in 1857. To date, the collected cases appearing in the medical literature of Denmark, England, France, Germany, and the United States total less than sixty.

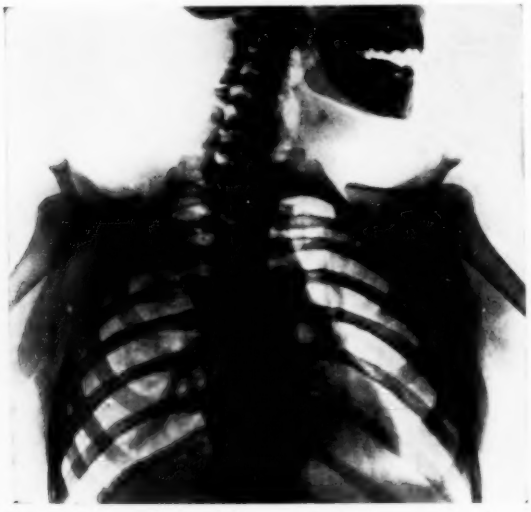

FIG. 1. Hereditary cleidocranial dystosis. This figure shows the absence of the clavicles with the exception of sternal stubs.

Nearly all the authors consider the absent clavicles as a part of a dystrophy—as a striking characteristic in a general condition. The French prefer the name "dystose cleido-cranienne hereditaire" and have helped clarify the situation by describing four main characteristics: the absence of the clavicles; the cranial malformations; the disorders of dentition, and heredity.

The clavicular dystrophy varies in degree from narrowing of the acromial end to complete absence of the entire bone. The narrowing on one or both sides has been described in the living, and is exemplified in the only anatomical preparation—a skeleton prepared by Professor Todd, reported by Terry.[14] A further change in degree is failure of union between the inner and outer halves of the bone—both the acromial and sternal portions are formed but definitely separated. The opposing ends are rounded and usually overlap. The gap is filled by a fibrous band. This condition is frequently bilateral and has been erroneously diagnosed as ununited fracture. The next most pronounced change is complete absence of the acromial end, the sternal end remaining as a stub of bone ½ to 1 inch in length; it is usually bilateral.

* Published with permission of the Surgeon General, U. S. Army, who is not responsible for any opinions expressed or conclusions reached herein.

Complete absence of the clavicles is rare, and in all the reported cases has been limited to one side, the clavicle of the opposite side being present although incompletely formed.

The anomalies of the skull are especially stressed in the French literature. The lateral diameter is increased, the fontanelles and the sutures close late. In one case, reported by Mouchet[11] the anterior fontanelle remained the size of the palm of the hand, at the age of forty-seven. Such decided cranial anomalies are not usual. Even in the reports by the French authors only traces of the cranial defects appear as sunk suture lines or delayed closure of the fontanelles.

Anomalies of dentition are more common. The primary teeth persist to the age of twelve; the secondary dentition is incomplete, irregular, and prone to caries. There are missing teeth, usually the upper canines, and supernumerary teeth.

The hereditary factor is stressed by all. The condition usually includes several members of one generation, but so far only two successive generations have been traced. Marie believes the hereditary fault is readily recoverable. The absence of proof pointing to a longer hereditary chain may be due to incorrect evidence. Most persons who have this dystrophy are not aware of it, and unless carefully examined would be classed as normal.

Clinically all the cases have been active, with good muscular development. While there is a tendency to short stature, there is no impairment in physical process. In all the reported cases the condition was unsuspected by the patient and was picked up in the course of a routine physical examination. None of the patients consulted a physician for the relief of disability, pain, or even discomfort, in the shoulder girdle. The absence of the clavicles permits certain movements impossible for the normal individual: for example, the shoulders can be pulled so far forward that

FIG. 2. Hereditary cleidocranial dystosis. Anomaly of the fifth metatarsal bone, right foot, and widening of the base of the corresponding proximal phalanx.

the deltoid eminences touch, without causing the slightest pain.

It is desired to add the following case especially as it presents features not described heretofore:

Miss R, aged eighteen.

Family history is negative. The father, mother, and sister have perfectly formed clavicles, heads and teeth. The father has periodic migraine, but otherwise is well.

Previous Personal History. A premature infant (7 mos.), weight at birth 4 pounds, 8 ounces. One supernumerary toe on the right foot. Breast fed. Was drowsy for the first three months. Pneumonia at six months. First walked at eighteen months. Tonsillectomy and adenoidectomy at five years. Measles, mumps, pertussis and chicken pox in childhood. Influenza in 1918.

In 1922, at the age of thirteen, the height was 57½ inches, weight 96 pounds: mentally alert, no signs of asthenia. Menses had not begun. Deciduous teeth still present. The only permanent teeth erupted are L 4, 5, 12, 14, R 1, 4, 6, 14. There are two supernumerary teeth lingual to the upper central incisors. Marked micro-development of upper and lower arches. Basal metabolic rate, —15. Thyroid extract was administered, checked by frequent B. M. R. observations, as well as the usual clinical procedures.

In 1923 (age 14) height 59¼ inches, weight varied from 84 to 89 pounds. Deciduous teeth extracted; additional permanent teeth erupting —L 3 and 13 and R 2, 5, and 13. Basal metabolic rate was held in normal range. Thyroid treatment continued.

In 1924 and 1925 thyroid extract continued. Basal metabolic rate held in normal range. During these two years, all the permanent teeth erupted except L 11 and R 11. All the teeth were in malposition.

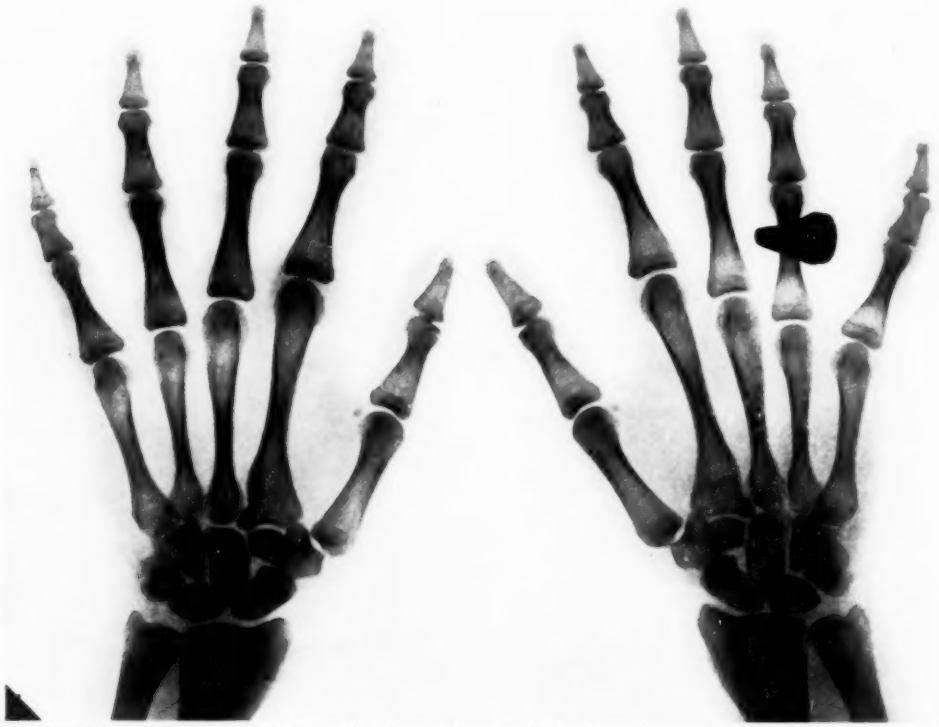

Fig. 3. Hereditary cleidocranial dystosis. Note the relatively long first metacarpal bone on each hand and the widening at the base.

Present Condition. Age eighteen. Height 60¼ inches, weight 96 pounds. A well-nourished, active girl, alert, highly intelligent. Swims, rides horseback, and dances well. So far as she knows has nothing the matter with her except bad teeth, and the fact that she is required to take thyroid extract. Can hold her own with any girl of her age in physical competition.

Physical Examination. The head shows an increased lateral diameter—14.5 cm. as com-

pared with an anteroposterior diameter of 18.75 cm. The frontal suture is depressed, the frontal eminences are unduly prominent. The teeth are small, irregular, and set at every angle. The shoulders can be pulled forward until the deltoid eminences touch in the midline.

Roentgen-Ray Examination.

(1) Clavicles (Fig. 1). All that remains of the clavicle on each side is a sternal stub, 6 cm. in length, 1 cm. in thickness, with rounded ends. Their density is less than normal. The acromion process of the scapula on both sides is rudimentary, the articular surface of the acromioclavicular joint is absent.

(2) The right 5th metatarsal bone is double (Fig. 2), united at the ends. The base of the proximal phalanx, 5th toe is widened. (The supernumerary toe formerly attached at this point was removed by operation during infancy.)

(3) The metacarpal bone of the index finger (Fig. 3) in both hands is elongated 2 cm.; the metacarpal bone of the middle finger is elongated 0.5 cm. The bases of these metacarpals are widened, the midpoint of the shafts constricted. The changes in the metacarpals are absolutely symmetrical for the two sides of the body.

(4) Skull. The anterior fontanelle is closed, but the bone here is much thinner than elsewhere. It is believed that the closure has been recent.

(5) Teeth. There are two supernumerary incisors.

This patient resembles the other reported cases in that she has the absent clavicles on both sides, incomplete, owing to the sternal stubs: the cranial malformation with the increased transverse diameter, the persistence of the sagittal sulcus, and the evidence of delayed closure of the anterior fontanelle: and the dental changes—delayed appearance of the permanent teeth until the age of fourteen, the poorly formed and malaligned teeth and the supernumerary teeth.

The case differs from those reported in the following particulars:

1. The father, mother, and sister have normal clavicles.

2. In addition to the dystrophies in the clavicle and skull, there are changes in the 5th metatarsal, right, in the 1st and 2d metacarpals, bilateral.

3. In addition to the anomaly of osseous development, there is partial failure of the thyroid gland. This was present in sufficient degree to increase body weight, but did not depress mental alertness. The thyroid deficiency must be interpreted as a part of the general process, not as the cause.

Acknowledgment is made to Major William Meister, Medical Corps, who discovered the absent clavicles on routine physical examination, and to Majors Wright and Fairbanks, Dental Corps, U. S. Army, who have been aligning and treating the teeth. Major Fairbanks will contribute a paper in about one year describing the methods and results from the orthodontic standpoint.

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THE RADIUM TREATMENT OF EXTENSIVE HEMANGIOMAS IN INFANTS

BY SANFORD WITHERS, M.D., AND JOHN R. RANSON, B.S., M.D.

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THE principal reason for presenting this brief paper is to stimulate discussion of this and other methods of treating bulky hemangiomas.

We will state the method, show 2 cases which illustrate the results obtained, and briefly discuss our reasons for adopting this procedure which is as follows:

Radon seeds of 0.2 to 0.3 mc. content are implanted throughout the tumor, allowing one implant to about 1 c.c. of bulk, special care being taken to see that no seed is left closer than 6 or 7 millimeters to the mucous membrane or skin surface. In other words, the growth is implanted as though it were malignant, but instead of using seeds of 1 mc. or more, we use seeds of $\frac{1}{3}$ to $\frac{1}{4}$ mc. for these large hemangiomas. An attempt is made to make this procedure as aseptic as possible.

Following the implantation and dressing we arrange to compress the blood spaces of the tumor by means of elastic or plain bandage over a gauze or sea sponge compress and in some cases by using a dental compound impression tightly bound in position. We are convinced that our results are better in those cases in which we can maintain compression of the tumor for the week following the treatment. We believe this applies to any method of treatment.

The following are our reasons for presenting this method of treatment.

In 1922 when the American Radium Society met in San Francisco we heard an excellent paper on this subject by Dr. Lawrence Taussig. The method of treatment given at that time advised the use of small doses of radium repeated many times over extended periods. The discussion brought out the point that the use of beta rays was probably the most efficacious treatment. The results shown by Dr. Taussig were excellent and justified the time and bother to patient and doctor.

We all know how the duration of treatment of these cases drags out into months and even years, and what an inconvenience and expense it is to parents to travel hundreds of miles to obtain a treatment for their child every two or three months.

We recall another paper, one presented with cases at a section meeting of the American Medical Association at Dallas last year. The author showed some badly scarred babies to illustrate his idea of good results. We received the impression that the author looked upon the deeply pitted and extensive scars as a legitimate result of his treatment and to be expected, and I am sure that others shared our impression.

With the following two facts in mind: First, that we must not mar or unduly scar the child; second, that we must develop a *one application* method for eradication of hemangiomas, we began experimenting with the use of relatively unfiltered radium and radon for the treatment of these cases.

The use of radon seeds of low activity implanted well below the surface proved to be the most successful of our attempts to produce an endarteritis and fibrosis in angiomas, in one application and with little reaction and scarring.

Following this method the growth should become more firm and be diminished in size in seven to ten days and should *not* show more than a mild erythema of the surface. In 9 out of 10 cases, retrogression should be

complete in six weeks following a single application.

CASE REPORTS

CASE I. (Figs. 1 and 2.) Baby B., aged six months at date of treatment, Jan. 20, 1925. Hemangioma of lower lip, angle of mouth and mucous membrane of cheek. The mass was growing rapidly at the time of treatment and made nursing tedious and difficult. The entire area was implanted with 19 seeds of about 0.3 mc. each totaling 5.2 mc. The growth had retrogressed completely within six weeks, and at the end of six months there was present very little scarring and practically no anatomical or functional disability. The child has developed as a normal healthy infant since treatment.

FIG. 1. Case I.

FIG. 2. Case I.

CASE II. (Figs. 3 and 4.) Baby K., aged eleven months at time of treatment, June 21, 1924. Hemangioma of buttocks, vulvae, rectum and vagina. Examination showed the vagina to be involved to the cervix. The rectum presented compressible, grapelike masses of angiomatous tissue, springing from a base of angiomatous mucous membrane, for a distance of 1½ to 2 inches above the anal margin. The act of defecation was impossible. The bowel moved only following enemata, then frequently accompanied by small hemorrhages.

FIG. 3. Case II.

FIG. 4. Case II.

The rectum and vagina were treated with radium in tubes (having a wall thickness of 0.35 mm. monel metal) covered with 0.5 mm. rubber. The amount of radiation to each—rectum and vagina—was 180 mg-hr.

Radon seeds were implanted as follows: 12 seeds of 0.25 mc. each were implanted in the vulvae; 8 seeds of 0.25 mc. each were implanted about the anal margin; 17 seeds of 0.25 mc. each were implanted about the periphery of the area of involvement. There were, then, 371 seeds totaling 9.25 mc. used in the treatment of the superficial part of this hemangioma. The growth completely retrogressed following this single treatment.

Note. The scarring of the right buttocks was due to previous treatment with escharotics, etc. We did not treat the buttocks.

The result has been satisfactory. The vagina is apparently normal except for some slight telangiectasis.

The rectum was strictured to a slight degree, but this has been overcome by finger dilatation.

The labia and perineum show very slight scarring, without telangiectasis or scar tissue banding.

Bowel movements became normal and the child was in good health when last seen.

SUMMARY AND CONCLUSIONS

We have proposed an alternative method for the treatment of bulky hemangiomas.

This method recommends the implantation of radon seeds of low content throughout the bulk of the tumor.

We further recommend the use of a compression bandage over the growth following implantation to partially collapse the blood vessel spaces.

We believe the success of the method depends largely upon the biologic effect of the beta rays in producing an endarteritis and fibrosis of the vessels involved.

A COMBINED TREATMENT FOR CANCER OF THE ESOPHAGUS*

A PRELIMINARY NOTE

BY POL. N. CORYLLOS, M.D., AND IRA I. KAPLAN, M.D.

NEW YORK CITY

IF left untreated cancer of the esophagus shows a mortality of 100 per cent. The nature of the disease, the difficulty of its early diagnosis, the location of the esophagus deep down in the posterior mediastinum, which renders exposure difficult and dangerous, the physician's failure to promptly order the patient to the surgeon, and most of all perhaps the reluctance of surgeons to operate in these cases, all these factors serve to explain the small number of successfully operated cases hitherto published.

We find only 4 cases successfully operated upon with resection of the tumor. These are Dr. Torek's case, a woman aged sixty-seven, who was operated upon with resection of the tumor and esophagostomy in March, 1913, and alive and in excellent health twelve years later; Lilienthal's case, a man operated upon in 1921, and who died a few months later from recurrence, and the cases reported by Hedblom and Eggers.

These operative successes, even though very small in number, render unjustified, in our opinion, although granting the absolute hopelessness of such cases, the surgeon's customary avoidance of any local or surgical treatment. We cannot completely agree with the position taken by some men in surgery and in radiotherapy, who state that a patient with a carcinoma of the esophagus is "better dead than operated upon" and that "the less we handle the esophagus the better off they are, and the longer they survive." Ordinarily the routine treatment for these patients consists in a gastrostomy, as early as possible, followed by tube feeding of a composite of properly balanced food elements so as to insure the patient at least 2500 calories each twenty-four hours, and a rest of the esophagus as

* From the Second Surgical and the Radiation Service, Bellevue Hospital, New York City.

complete as possible by prohibiting any feeding through mouth. By this treatment the local symptoms are certainly greatly relieved, weight is gained and life prolonged, but nevertheless this does not prevent the growth and extension of the tumor, followed by death in a short time.

The question then arises, whether anything more can be done for these unfortunate patients, other than the treatment stated, and whether we shall consider the abstention from any local treatment as a settled practice. In an endeavor to answer this question, we have started this year in our respective surgical and radiotherapy departments in Bellevue Hospital a systematic study of the problem, with the idea in mind that only the close collaboration of internist, surgeon and radiation therapist can advance its solution.

As a matter of fact, over 90 per cent of cancers of the esophagus belong to one of two varieties: (1) adenocarcinoma at the lower end of the esophagus; (2) squamous cell cancer in other locations. The former extends from the cardia and in early cases can be operated abdominally, the latter which is most common, generally has an endoesophageal beginning, and, as stated by Dr. Chevalier Jackson in his remarkable paper on the subject: "Here we have a local process of a relatively low degree of malignancy; it is reasonable to expect a good percentage of cure if the surgeon could get the patient in this stage, but he never does and never will, so long as present obsolete diagnostic methods are taught to the profession." The important characteristic of the squamous celled carcinoma is, as Willy Meyer states, "the most benign of all carcinomata of the alimentary tract." Such being the case there is really no reason for abstaining from operating upon those cases; on the contrary, there is every reason to operate, and it will be done as soon as the practitioner is taught that in every case of "trouble in swallowing," no matter how slight, the possibility must be considered of a cancer of the esophagus, and a roentgen examination followed by esophagoscopy is necessary and should be carried out at once. It would be highly advisable for the surgeon to be prepared to handle the esophagoscope safely and skilfully, in order to perform the esophagoscopy himself, for from it he will obtain most valuable information for the operation.

So much for the early cases. Regarding the advanced cases, Lewis, Pancoast, Newcomet, Quick and others have published extremely valuable papers on the radium treatment, and Manges, Pancoast, Pfahler, Borzell and others on the roentgen-ray treatment.

We have taken up this palliative treatment of the advanced cases which are the only ones we ordinarily see in our wards. We have treated so far 3 cases, absolutely inoperable, with more or less complete obstruction of the esophagus and with rapidly progressing cachexia, in the hope of possibly transforming the not very advanced cases from an inoperable to an operable state.

This work will require a long time before we are enabled to reach any conclusions. The results, however, in the 3 cases herewith reported are so startling that we deemed it auspicious to publish this preliminary note at this time, so as to stimulate the efforts of other workers in this field.

The method consists in careful regulation of the artificial feeding in order to augment to the maximum the patient's strength, the external application of high voltage roentgen rays to the local lesion and the insertion directly into the tumor mass, via the esophagoscope, of specially prepared removable platinum filtered seeds of radium emanation.

As soon as diagnosis is made a gastrostomy is performed and the patient is fed with a properly balanced feeding of at least 2500 calories per day, through the gastrostomy tube. As soon as the artificial feeding plan is working effectively, radiation therapy is begun.

RADIATION TECHNIQUE

Roentgen Rays. High voltage roentgen rays, 200 kv., 4 ma., filtered with 0.5 mm. copper and 1 mm. of aluminum, applied at a distance of 30 cm., over the anterior and posterior mediastinum, directed through 9 × 12 cm., directly over the lesion as localized by the roent-

genogram. The dose given is 25 per cent of a skin erythema each day, alternately anterior and posterior, each area receiving 4 doses. This is accomplished in eight days, the patient bearing this treatment well, experiencing no discomfort and often improving temporarily.

Radium. Immediately following the treatment with roentgen rays the radium implantation is carried out. The amount of radon and the number of implants required is determined by the size of the lesion as noted in the roentgenogram. Six to eight implants of 2 to 3 mc. each have been used in these cases. The implants are platinum tubules of a wall filtration equivalent to 0.2 mm., in which are placed the glass ampules of radium emanation and to which are attached silk threads 25 inches long. The patient is prepared as for operation, and a preliminary dose of morphine $\frac{1}{4}$ grain with atropine $\frac{1}{100}$ grain given hypodermically. Cocaine anesthesia of the upper larynx and pharynx is then done and the patient placed on the operating table in the position for esophagoscopy. The esophagoscope is passed down to the lesion and when carefully done the patient is afforded only slight discomfort. After the canal is cleared and the lesion located, the prepared radon seeds are implanted directly into the lesion with applicators specially made for this purpose and which on removal leave the seeds in place.

The seeds are preferably placed in the lower end of the lesion first and the upper end last, the distribution being made according to the extent and character of the lesion as observed through the esophagoscope. The instrument is withdrawn carefully and the protruding threads attached outside the mouth to the cheek wall. The patient is put to bed and forbidden any food or fluids by mouth. He is advised not to swallow the sputum that may form in the mouth. Feeding is carried on through the gastrostomy tube. The patient is allowed up and about the ward the second day, and experiences very little pain or inconvenience. Codeine in one grain doses is given as needed and is sufficient to relieve the pain.

The radon is left in place six to eight days, depending on the dose to be given, about 1500–2000 mc-hr. At the end of the allotted time the seeds are removed by pulling on the protruding attached threads and come out loosely without pain or difficulty. The patient is allowed a small amount of fluids by mouth on the following day, one glass of milk or water, and this quantity is increased three or four days later. In one week after treatment soft diet is permitted.

The 3 cases herewith reported are now six weeks postoperative, eating a mixed diet by mouth, have gained in weight, one 26 pounds, one is back at work as railroad steward and living comfortably and free of pain. We propose to follow up carefully those patients so as to report their evolution and outcome.

CASE REPORTS

CASE 1. Mr. J. B., aged forty, married. Admitted April 4, 1927.

Chief Complaint. Difficulty in swallowing and vomiting after eating.

Family History. Negative.

Past History. Irrelevant.

Present Illness. Five weeks before admission noted that solid food stuck in throat; pain on forcing food. Vomited food previously eaten. Gradually becoming weaker with increased difficulty in swallowing, lost 25 pounds, swallows liquids only.

Physical Examination. Very poorly nourished. Shows slight emphysema, slight spasticity of upper abdomen. Roentgenoscopic and roentgenographic examinations show almost complete obstruction at junction of middle and lower thirds of esophagus, dilatation above obstruction. On April 7 gastrostomy performed (Janeway technique).

Examination on May 3 showed an emaciated man able to travel about. No palpable mass. Gastrostomy wound in left upper quadrant. Roentgenogram shows neoplasm of lower third of esophagus just above the stomach, with complete obstruction of esophageal lumen.

Roentgen-ray Treatment. From May 3 to May 11, 1927, roentgen therapy to anterior esophagus, 100 per cent; roentgen therapy to posterior esophagus, 100 per cent.

On account of the rapid weakening of the patient, immediate local radium application was decided upon.

Implantation of Radium Seeds. An examination of the esophagus on May 13 shows cancerous infiltration of the thoracic esophagus,

lower third. Posterior fold is nodular, the right fold shows fungations, bleeding moderately,

Fig. 1. Case 1. Roentgenogram taken on May 11 showing complete obstruction of lower third of thoracic esophagus. Dilatation above.

in a length of 5 cm., the mucosa is hard, rigid, without respiratory movement.

Eight radon seeds were implanted with the special applicator, in a depth of 2 to 4 inches,

Fig. 3. Case 1. Roentgenogram taken June 3, esophagus permeable; dilatation above stenosis still persists.

in the obliterated mucosa. Figure 2 shows the disposition of the platinum seeds; the threads of the seeds 25 inches long, were fixed on the cheek of the patient, having been passed through a rubber tube to prevent pieces being

Fig. 2. Case 1. Roentgenogram taken May 13; eight seeds implanted in tumor, 3.12 mc. each.

cut through by the patient's teeth. Postoperative history uneventful; patient was up on the second day.

On May 13 the seeds taken out by gently pulling on threads (total amount 2215.78 mc-hr.).

Fig. 4. Case II. May 2, 1927. Carcinoma of thoracic esophagus, mid-third, still permeable, but showing huge dilatation above stricture.

On May 27 the patient felt greatly improved, can swallow without choking feeling in chest.

June 3, 1927, patient feels better, no pain, swallows two glasses of milk daily without trouble, burning sensation around gastrostomy wound. Allowed cereal by mouth. Remarkable improvement. (See Fig. 3.)

Case II. Mr. J. J., aged fifty-seven, single, colored. Admitted Feb. 11, 1927.

Fig. 5. Case II. May 10, 1927. Radon seeds implanted.

Chief Complaint. Pressure in chest when swallowing, and sticking of solid food in throat.

Family History. Negative.

Past History. Irrelevant.

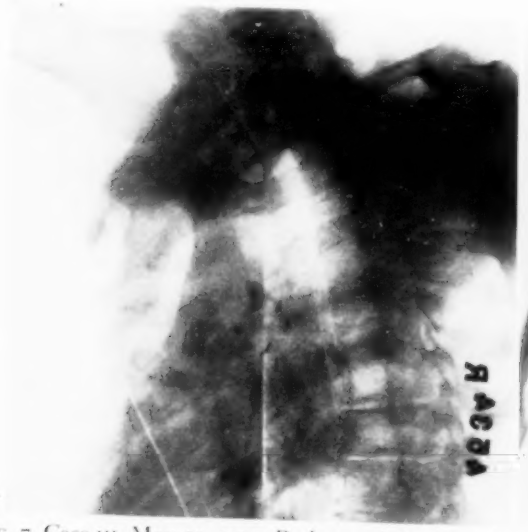

Fig. 7. Case III. May 20, 1927. Radon seeds implanted, six only visible, the other two having been pulled out during contraction of esophagoscope.

Present Illness. Four months ago noted pressure in chest on swallowing, difficulty in swallowing solid foods, seem to stick, dull pain behind breast bone, no vomiting, not constipated, lost – pounds during the last four months.

Physical Examination. Shows well-developed negro. No abnormal physical findings.

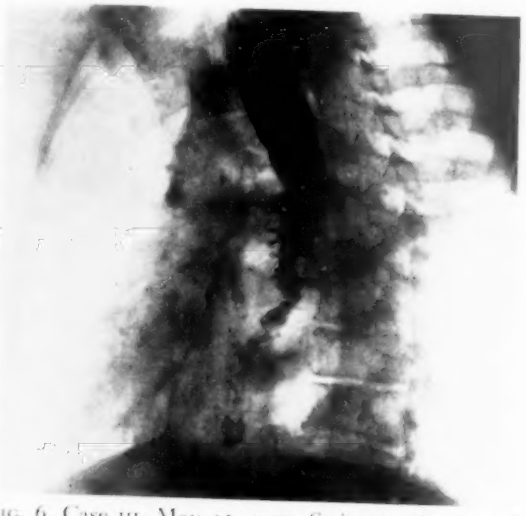

Fig. 6. Case III. May 12, 1927. Stricture of union of middle and lower thirds of esophagus. Esophageal bronchial fistula; larger bronchi left and posterior to the heart are visualized; no thoracic metastasis.

Wassermann negative. Roentgenographic examination shows cancer of middle third of esophagus.

Fig. 8. Case III. June 24, 1927. Esophagus permeable, esophagus bronchial fistula not filled except in its beginning. Compare with Figure 6.

On Feb. 23 gastrostomy done. Swallowing somewhat better after operation. From March 11 to March 22, 1927, roentgen therapy to anterior esophagus, 100 per cent; roentgen therapy to posterior esophagus, 100 per cent.

A roentgen examination on March 24 reveals the presence of a carcinoma of the middle third of the esophagus. April –, roentgen therapy to anterior mediastinum, 25 per cent. A reexamination of the esophagus on May 3, 1927, reveals stenosis of the area previously described with some irregularities of this border.

Esophagoscopical findings, carcinoma of posterior and lateral left wall of the middle third of the thoracic esophagus (Fig. 4).

Implantation of radon seeds, May 6, 1927, same technique as in Case 1. Roentgenogram (Fig. 5) shows seeds implanted. Postoperative history uneventful. May 11, seeds removed (total dose 2010.61 mc-hr.).

Since operation patient has returned to his duty as steward in private car. On June – the patient wrote that his throat was nearly normal and he was swallowing ground and soft food with scarcely any feeling, using tube night and morning for safety.

Case III. Mr. C. B., aged forty-nine, single. Admitted Dec. 30, 1926.

Chief Complaint. Pain in chest. Lost 20 pounds in past six months.

Past History. General health good. No operations nor previous illness.

Family History. Negative.

Present Illness. Five months before admission noted regurgitation after eating. Two months before admission was in another hospital and examined and was told he had cancer of the esophagus; while there bougies were used to dilate the obstruction. Examination at Bellevue Dec. 30, 1926, showed pale, thin, cachectic man. The only external finding was slight tenderness over the sternum. Roentgenoscopic and roentgenographic examinations showed deformity and constriction of the esophagus, involving over one-third. Blood examination showed R.B.C. 4,900,000; W.B.C. 15,000; hemoglobin 85 per cent; polymorphonuclears 81 per cent

On Jan. –, 1927, gastrostomy performed under general anesthesia (Janeway technique). Recovery good except for leakage about abdominal wound. Gained – pounds in one and a half months after operation. Taking semi-solid food by mouth. Feb. 16, patient discharged. March 8, readmitted, complaining of trouble with gastrostomy wound, and increasing difficulty in swallowing by mouth. March 11 operative revision of gastrostomy wound. Discharged April –. Roentgen examination at this time showed involvement of lower two-thirds of esophagus. Patient feels well but has not gained weight.

Roentgen therapy started same techinque as in Case 1, and patient discharged from the hospital April –. May 12 readmitted to hospital, poor condition, weak, cannot swallow at all. Roentgen examination revealed marked constriction and bronchial esophageal fistula, and complete obstruction (Fig. 6). Patient has coughing spells.

Radium Implantation. Esophagoscopic examination shows cancer, ulcerated, of the union of middle and inferior thirds of thoracic esophagus, indurated, immobile posterior and lateral folds, creases between folds filled with oozing blood. On posterior fold indurated surface.

Eight radon seeds were implanted by the same technique as in Case 1, but by taking off the esophagoscope the threads were entangled and caught on the esophagoscope and the seeds came out. On May 19 the implantation was repeated, by the same technique, six seeds out of the eight remained in the esophagus, two being pulled out when the esophagus contracted (Fig. –).

Postoperative history uneventful, second day patient was up, complaining of sore throat and slight pain in the chest. May 27, seeds removed easily (total dose 1627.92 mc-hr.). June 28, much better, has gained 26 pounds since radium treatment, swallowing food by mouth without difficulty. No mediastinal pain. Occasional cough. Roentgen findings reveal previous constriction markedly relieved, bronchial fistula almost invisible.

THE EFFECTS OF ROENTGEN RAYS UPON THE KIDNEY*

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THE experimental production in animals of a chronic glomerular nephritis resembling that seen in man would undoubtedly be of immense value. Years ago it was noted that irradiation produced contracted kidneys. In 1905 Schulz and Hoffmann[1] and also Buschke and Schmidt[2] noted these changes but believed that the primary alteration was a tubular degeneration and that the glomerular changes were secondary. Domagk[3] on finding a contracted kidney in a patient who had received massive doses of roentgen rays for an abdominal tumor was at first of the opinion that a chronic glomerular nephritis was thus produced. His experiments with animals, however, convinced him that the changes were similar to those noted by the above named workers. Thereafter he noted that similar changes could be found in the kidneys of patients who had received large doses of roentgen rays through the abdomen. He found no evidence of arteriosclerotic changes in the vessels and reported that the glomeruli were relatively well preserved, and that the primary change was tubular degeneration. In an earlier paper, however, Gabriel[4] reported the effects of irradiation upon the kidney showing that the blood vessels were primarily affected, those in the medulla being first involved. He produced a dilatation of the vessels with small doses and a constriction with large doses, and histologically found an atrophy and hyalinization of the glomeruli with secondary tubular changes. Very recently Hartman, Bolliger and Doub,[5] Hartman[6] and also O'Hare[7] and his coworkers reported the production of a chronic interstitial and vascular nephritis following irradiation of the kidneys in animals, the essential histological pathology thus produced being degeneration of the tubuli with replacement by fibrous connective tissue, thickening of the blood vessels, and atrophy and hyalinization of the glomeruli.

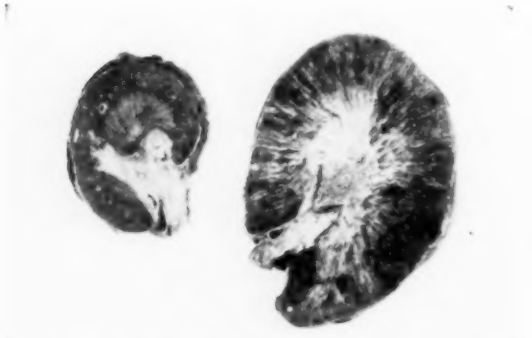

FIG. 1. Section through kidney (left) seven months after exposure to 7 erythema doses as compared to normal (right).

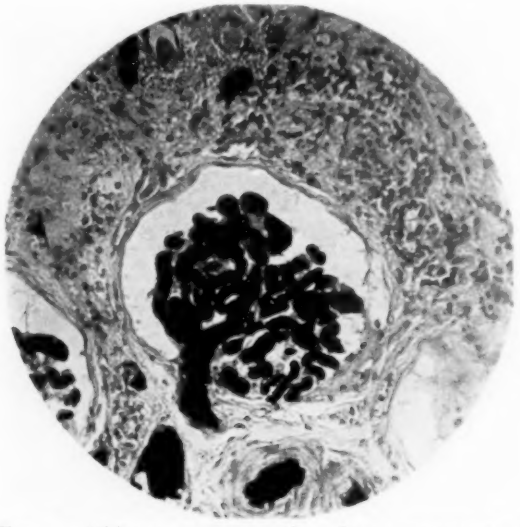

FIG. 2. Kidney seven months after exposure to 7 erythema doses injected with india ink, showing the absence of tubuli and capillaries, the abundant scar tissue, and the glomeruli filled with ink.

In March, 1926, we began experiments to observe the effects of measured roentgen rays upon the kidneys in dogs, and as we were interested principally in the histological pathology, no functional studies were made.

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METHOD

The application of roentgen rays was made under ether anesthesia through a midline abdominal incision, directing the rays through a lead tube 6½ inches long and 2½ inches wide which was lined with a 1 mm. aluminum plate. In this way the kidneys were left in their normal position and all other organs were well protected from the rays. As a rule, the kidney on only one side was treated, leaving the remaining one as a control. The exposures were made by a 10 inch Standard roentgen transformer with a limited capacity setting. Under the treatment conditions of 140 kv., 5 ma., 2 mm. aluminum filter, at 11 inch distance, the roentgen-ray output was 65 R per minute (40 R of the German Bureau of Standards). About six minutes' exposure represented a human erythema dose. By this exposure, the surface of the kidney received 390 R primary dosage. The secondary radiation from the kidney was not measured, but with the smallness of both the area of rays and of the irradiated object this was evidently very little. The penetration of the rays through an average sized kidney was determined by submitting photographic films placed above and below the kidney to various exposure times and then comparing these films by use of a photometer. About 70 per cent of the incident radiation was found to pass through the kidney, the average energy received by the kidney as a whole being about 90 per cent of the incident energy.

In all, 12 dogs were thus exposed, the dosage of roentgen rays varying from 1 to 7 skin erythema doses, and the time elapsing between exposure and autopsy varying from two days to seven months.

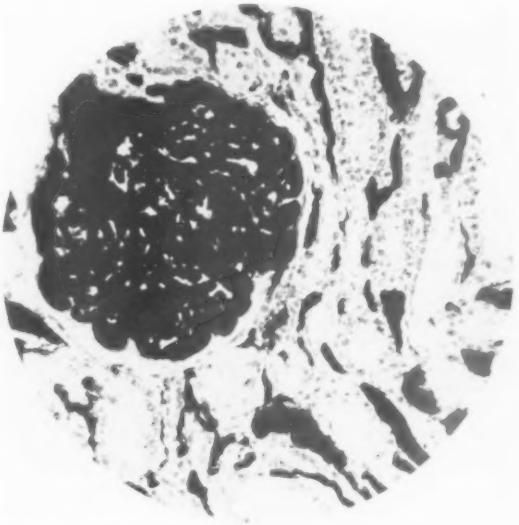

FIG. 3. Control kidney of the same dog as Figure 2 injected with ink.

FIG. 4. Rectangular scar twelve weeks after exposure to 3⅓ erythema doses.

The vitality of the renal epithelial cells was studied by the appearance of granules after intravenous injections of lithium carmine.

Circulation through the kidney, particularly the glomeruli, was studied by injection of india ink into the renal artery.

RESULTS

The extent of the pathological lesions produced varies directly with the dosage of roentgen rays and the time elapsing between exposure and autopsy.

A small dosage results in a degeneration of the tubuli for only a short distance below the capsule in that region directly exposed to the roentgen rays. In an average sized kidney an exposure to about 3⅓ erythema doses results in changes up to the medulla, while following twice this exposure the entire thickness of the organ is affected.

Two days after exposure to 5 E.D. the kidney is swollen and hyperemic, the

glomeruli and all the capillaries being engorged and packed with red blood corpuscles.

Two months after a similar exposure the kidney is quite apparently reduced in size. Histologically the changes appear to be less marked in the tissue farthest away from the exposed surface. The *tubuli* are degenerated and new-formed connective tissue is abundant. Lithium carmine, which has been injected, is entirely absent except as

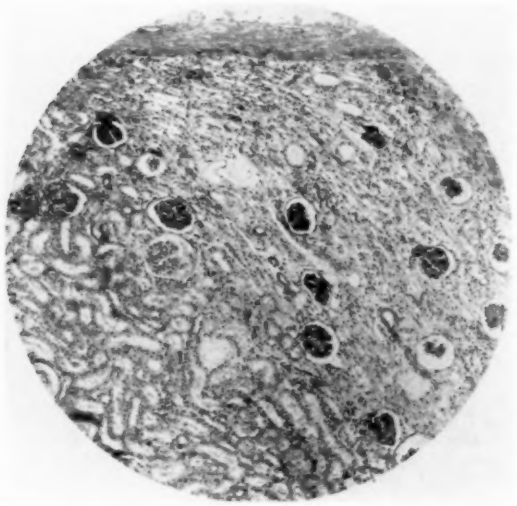

Fig. 5. Microscopic section through scar of Figure 4 showing sharp demarcation between irradiated and normal tissue.

it appears in the small islands of tubuli which still remain here and there imbedded in scar tissue. The medium sized blood vessels appear somewhat thickened but with no hyaline nor fatty changes. Occasionally a longitudinal section of such a vessel gives the impression that the vessel has become tortuous by the contracting scar tissue, and that the thickening is more apparent than real. The *glomeruli* appear relatively well preserved. Bowman's space is wider than normal. The tufts are smaller, but otherwise are little altered.

Seven months after exposure to 7 E.D. the kidney is about one-fifth its normal size (Fig. 1) and uniformly contracted. Here the scar tissue has so replaced the tubuli that not even single islands of the latter remain. Carmine granules are entirely absent. The capillaries between the tubuli have been obliterated to a great extent. The glomeruli, however, though distorted by the contracting scar tissue, are relatively well preserved. India ink injected through the renal artery under normal pressure flows quite readily through the tufts, filling them (Fig. 2) almost as completely as in the control kidney (Fig. 3). The control kidney, of course, undergoes some hypertrophy, while in the irradiated kidney the tufts are smaller due to atrophy following obliteration of the efferent capillary circulation, the degree of atrophy of the tufts being a direct index of the degree of capillary obliteration.

A small area exposed to about 3 E.D. results after twelve weeks, in a depressed scar (Fig. 4) which extends to the medulla. Histologically the picture is similar to the above described kidney. The lesion, however, is interesting in that the tissue immediately adjacent to the affected area is practically intact and shows fine carmine granules in the epithelial cells of the tubuli contorti, while in the scar area no carmine is present. Evidently the secondary radiation from the kidney is very small, and only those tissues directly penetrated by the rays are involved.

CONCLUSIONS

Irradiation of the kidney produces a progressive degeneration of the tubuli, with replacement by new-formed connective tissue, and without signs of regeneration of the broken down tubuli. The glomeruli, in spite of the marked tubular changes remain practically unaltered, their reduction in size and distortion being produced only secondary to other changes. In chronic glomerular nephritis, as seen in man, the glomerular changes are primary and the tubular changes secondary. In the irradiated kidney this process is exactly reversed, the tubular degeneration being primary, this being followed by scar tissue formation, obliteration of the capillaries and finally glomerular atrophy. The contracted kidney thus produced is therefore the end result of a nephrosis.

We are greatly indebted to Dr. R. H. Jaffé for his many suggestions and aid in the accomplishment of this work.

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THE IMPORTANCE OF VASCULAR PERMEABILITY IN THE THERAPEUTIC USE OF ROENTGEN RAYS AND RADIUM IN MALIGNANT DISEASE*

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BECAUSE of certain difficulties, roentgen sickness and other reactions, especially damage to blood cells, incident to the administration of intensive roentgen-ray treatments in the high plateau regions of Mexico, I have been forced to adopt continuous small dose treatments. The unfavorable reactions to intensive therapy are of importance because of insufficient oxygen in the atmosphere. They have at times been followed with fatal consequences. Three years ago (1924) I presented this method with observations on a number of cases in which it had been tried out.

Since then other workers in lower altitudes have shown a preference for similar therapeutic methods (Holzknecht, Anschütz, Schinz, Pfahler). The working hypothesis of their methods and also that of mine is based on the supposition that the cell in mitosis is particularly radiosensitive and that small daily doses destroy the mitosis in process, causing within a certain time the total disappearance of the tumor. This hypothesis was the point of departure of the glucose radiotherapy of Mayer and has led to the method of external continuous radium therapy which Mallet, Coliez and Regaud have recently published. Experience has proven, without doubt, that the application of this hypothesis can be attended with success, but statistics show us that its successes are fewer in number than those obtained by the older method of intensive doses. In other words, the initial hypothesis of Seitz and Wintz, that tumors can only be destroyed directly by intensive doses still remains the most successful from a practical point of view. At the same time thousands of experiments have proven that this hypothesis will have to be displaced by another which can explain the successes due to small doses as well as those due to the large doses, which will give greater regularity in the results to be obtained and which will not only explain inevitable failures, but will also predict them, just the same as we can predict by the capillary microscope when the skin will respond to the erythema dose by the formation of an ulcer.

The theory of Opitz, that rays tend to increase a natural immunity of the organism, the necrohormonic theory of Caspari and the theory of cellular immunity of Theilhaber represent, without doubt, a progress in this direction. At least they can explain the phenomena of the healing of cancer from an experimental biologic point of view. But the relatively insufficient number of successes furnished by the therapeutic methods deduced from these theories, proves that we should not consider them as fully determined, but that we must seek other theories in order to

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arrive by further experimentation at surer and more positive results.

The following clinical observation together with the results of recent experimental researches has suggested to me a new theoretical explanation of the healing of tumors following irradiation.

The observation refers to an epithelioma of the sclerotic portion of the conjunctiva. The tumor had grown rapidly and when I saw it first, had reached the size of the cornea, and on two points extended to the limbus (Fig. 1, Nov. 18, 1926). Surrounding the tumor, there was an active inflammatory redness, formed by numerous small blood vessels, some newly formed, others dilated capillaries. On the border adjacent to the cornea, however, there were no blood vessels and no inflammatory reaction was observed. The tumor was flat, but dense enough to hide from view the larger blood vessels, which appeared to run to the border of the tumor and then suddenly disappeared as if cut off.

Fig. 1. Showing tumor on Nov. 18 and Nov. 24, 1926.

As the roentgen therapy of a case previously cited had given satisfactory results only after a long time and had been followed after a year by a delayed reaction in the form of a glaucoma which led to enucleation, I decided to treat the case with radium. Accordingly I applied daily without filter 13 mg. of the element for ten minutes, at a distance of 1 mm., with a total exposure of 90 minutes.

At the end of this treatment (Nov. 24, 1926) the vascularized sclerotic part of the tumor border presented not the slightest change, especially was there no tendency to advance. The avascularized corneal border of the tumor, on the contrary, had definitely advanced over the cornea to the extent of 1 mm.

On the sixth day (Nov. 30, 1926) this phenomenon was still more marked and an examination with the corneal microscope of Vogt showed that the tumor had also penetrated deeper into the corneal tissues. At this time the inflammation of the sclerotic border was somewhat accentuated and the corneal border still remained avascular.

On the 15th day (Dec. 9, 1926) I saw the patient again. Except for a few very small isolated areas, the tumor had disappeared and in its place could be seen in the conjunctiva, clear and non-adherent, a network of dilated vessels. At three points were observed these compact isolated cellular masses measuring 0.25 to 1.50 mm. At other points this vascular network was still slightly covered over by a light milky film. It is very probable that the vascular network had previously existed and that it had been entirely hidden by the opaque neoplasm of which now remained only this veil-like remnant. The corneal part of the tumor except two very small cellular islands, one in the inferior and one in the superior margin, had also almost completely disappeared (Fig. 2).

Fig. 2. Showing tumor on Dec. 9, 1926.

Figure 3 represents, as seen by the microscope, the lower area and the conglomerate cellular rest in the sclerotic part. At the center of the latter, two capillaries become visible. The rest of the cellular mass is still entirely avascular, but its border is surrounded by very numerous fine dilated capillaries. The corneal island presents the same phenomena. It is everywhere surrounded by newly formed capillaries, which appear to blot out the border. In

fact, the center remains completely opaque, but its border is becoming transparent where the vessels become visible.

On the 26th day (Dec. 20, 1926) the tumor had completely disappeared macroscopically. The vascular network still existed although really much less injected and only at one point could be seen a slight milky opacity. In another point the conjunctiva was swollen with a gelatinous edema which on the following day had almost disappeared.

Three months later (April 5, 1927) almost all phenomena had disappeared and only a slight hyperemia could be seen. The patient remained under observation because of a persisting milky opacity, the appearance of which had remained constant.

These observations on living neoplastic tissue led to the following deductions:

1. The vascular system must play a rôle of first order in the phenomena of healing, because the growing of the neoplasm on the corneal border stopped only when vascularization appeared.

2. Neither the presence of the network of blood vessels nor their dilatation was sufficient to explain the curative effect of irradiation because they existed on the sclerotic border of the tumor prior to the beginning of the treatment, without having inhibited its growth.

3. It follows that the curative effect must have been brought about by a change in the vessel wall, a change which with difficulty one might attribute to another phenomenon than the alteration of the permeability of the vessel wall for different substances, an alteration which may represent increased permeability as well as diminished permeability. Thus, on the one hand, it is possible to change the metabolism of the neoplastic cell and, on the other, to eliminate by resorption the products of degeneration.

4. This alteration of the vessels must be an indirect manifestation, if not, we could not explain the healing of the corneal part, because, as we have described, six days after treatment this part was still avascular, but subsequently disappeared without further treatment.

5. The impression was obtained that the cells of the tumor were simply absorbed or they were transformed into normal cells. In fact the rapid disappearance of the tumor would have caused the formation of an ulcer if the destruction had been direct, as for example, that produced by electrocoagulation. It seems therefore most probable that the healing was produced indirectly by a transformation of metabolism, either by the artificial production of immunizing substances by roentgen rays or by natural immunity which became activated following the increased permeability of the blood vessels.

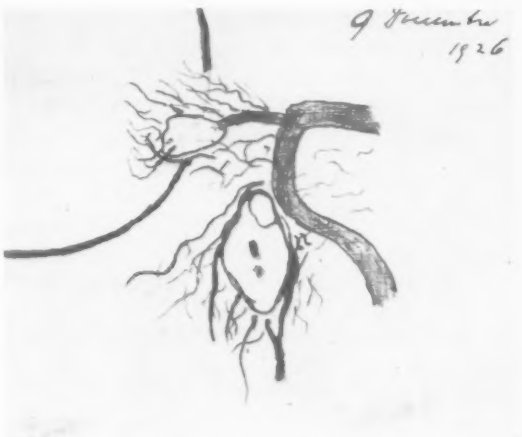

FIG. 3. Microscopic section showing lower area of tumor and the conglomerate cellular rest in the sclerotic part, Dec. 9, 1926.

Let us compare these hypotheses with certain experimental facts. First with the phenomena of immunity in syphilis recently discovered by Dujardin and Dumont, by Lefèvre de Arric and Miller (Bruxelles) and by Mooser (Mexico); then with the findings of the capillary microscope, especially those relating to vital staining of Cramer; and finally with the important studies of Warburg on metabolism.

1. Mooser of Mexico has proven, that *Spirochaeta morsus-muris* which produces human Sodoku (rat-bite fever) can be found in the periphery of annular cutaneous lesions and in lymph glands at a time when the blood serum has already developed marked spirocheticidal properties. He therefore concludes that the antibodies do not possess the property of traversing the intact blood vessel walls. He explains

the annular character of the cutaneous manifestations (found also in syphilis) by impaired blood vessel walls which permits extravasation of blood or plasma. As soon as the antibodies are found in the blood in sufficient concentration the spirochetes disappear in the areas where extravasations have occurred and the lesions heal in their center, but at the same time, they remain active at the periphery where the vessels are only slightly damaged. The lesions can even progress but heal spontaneously later when a sufficient quantity of antibodies has traversed the vascular walls.

Lately Mooser has extended his theory of impermeability of the blood vessels to all the antibodies (globulins). The fact, for instance, that *Spirochaeta duttoni* remains alive and virulent within the brains of rats for a considerable length of time after the spirochetes have disappeared from the blood on account of spirocheticidal antibodies can, in his opinion, only be explained by an impermeability of the blood vessels for antibodies. He inoculated such immune rats with hydrophobia and was able to free their brains from the spirochetes in about 30 per cent of the cases. The pathological substratum of hydrophobia is an encephalitis and a successful sterilization of the brains in his experiments was directly related to the extension of the inflammatory reaction of the brain and to the concentration of the blood antibodies.

Dujardin and Dumont have proven experimentally, that the antibodies of syphilis do not pass from the blood to the cerebrospinal fluid, if the impermeability of the choroid plexus or the meninges is not altered by the intra-arachnoid injection of distilled water.

Lefèvre de Arric and Miller of the Pasteur Institute of Bruxelles have proven for the neurophile virus filtrate of herpes, that its injection into the veins, usually without consequence, produces a fatal encephalitis with positive findings in the cerebrospinal fluid if the injected animal is given a blow on the head, producing thereby rupture of blood vessel walls.

The same phenomena are observed on changing the permeability of the vascular endothelia by the injection of certain substances, namely urotropine, biliary acids and salts, urates, sodium salicilate and potassium bromide. On the other hand, potassium iodide, hydrochloride of quinine and neosalvarsan are without effect. The possibility that the permeability of the blood vessels plays a similarly important rôle in the production as well as in healing of neoplasms, is based on the following well-known facts, mentioned in connection with another subject, by Anderson. We know that syphilitic paralysis and ulcers of the leg as well as carcinoma may be healed after an intercurrent infection of erysipelas or scarlet fever. The same phenomena have been observed in regard to keloids, eczema, psoriasis and lupus, all maladies which can be made to heal by radiotherapy. The healing can be explained in these cases by the production of an erythema. By comparison with the phenomena of immunity just described we are led to think that the erythema dose, which produces the healing of cancer, has above all the effect of increasing the vascular permeability for certain protective substances.

2. Desjardins of the Roentgen Department of the Mayo Clinic believes that the regression of tumors is due to the obliteration of blood vessels, which deprives the tumor of the source of its nutrition. The case, which we described above, our daily experiences with roentgen therapy and biologic experimentation sufficiently prove that the process is in reality a much more complex one.

The erythema dose which determines the healing of cancer does not produce even the slightest destruction of the skin and even after repeated irradiations we find numerous telangiectatic vessels, long before trophic disturbances and necrosis by vascular occlusion occurs. The capillary microscopic observations of Otfried Mueller, David, Gabriel, Siedamgrotzky and others confirm these facts. According to the dose, they found dilatation, slight, or more or less marked, edema or hemorrhage. Only later does the endarteritis obliterans appear. Ricker, Lazarew and Lazarewa have shown by pharmacodynamic experiments on irradiated rabbits that the vasodilators are more excitable during the erythema. At the same time the excit-

ability of the constrictors is diminished. This alteration persists for a duration of two months. Siedamgrotzky and Zimmermann showed that the function of the capillary endothelium, on which diffusion, oxidation and nutrition of the tissues depend, is transformed. Kroetz and others proved that after irradiation vessel walls and cell membranes allow two or three times more albuminous substances to pass than normal. Only after high doses and after long-continued use of the roentgen ray does the permeability diminish and finally remain definitely below normal.

Therefore it seems that the idea in connection with the concrete case mentioned in the beginning, the healing of the tumor with an alteration in the blood vessel walls in the sense of a changed permeability, is based on recognized proof.

Now arises the question of finding out if the subsequent phenomena in the healing of the neoplasm are due to the roentgen rays *per se* or if the organism is capable of causing the disease to regress by some protective power within itself. One can scarcely doubt the existence of indirect immunizing processes, making impossible tumor formation. However, Desjardins, in the article just cited, denies it absolutely. The experiments of parabiosis of Behne and Zacherl proved the formation in the blood of new substances by the appearance of blood changes and temperature elevations in the non-irradiated as well as in the irradiated animal. The well-known experiments of Opitz, Vorlaender and Kok prove that we must ascribe to these substances an immunizing rôle. The same happens in the research work of Murphy, who observed the healing of cancers in mice after general irradiation, the tumor being protected, while other tumors directly irradiated grew freely when transplanted to untreated animals. At the same time, prophylactic irradiation of the animal prevented tumor transplants from taking and *in vitro* tumor cells were resistant to all therapeutic dosage.

The nature of these changes is not yet clear. The erythema dose produces a calcium retention and an alkalosis of the blood, which opposes the tendency toward acidosis and the poor calcium content of the carcinomatous cell. The quantitative proportions of sodium chlorides and bicarbonates, which determine in the blood the acid-base balance are changed. This fact, probably of secondary importance, is based on the disintegration of albuminous bodies. By the refractometer the albumin content is observed to be increased. This is explained by the fact that the finely divided colloids, albumin for example, are transformed into less fine colloids as euglobulin, pseudoglobulin and fibrinogen, in the formation of which the superficial tension is diminished.

The fact that the irradiation of serum *in vitro* does not produce these same changes, speaks in favor of the production of these substances by cell destruction (leucocytes, lymphocytes, pathological cells). The idea that irradiation works in the same way as the therapeutic injection of extraneous albumins would appear logical, but the latter is not exactly equivalent to irradiation. By irradiation other substances appear and in tumors, the products of disintegration of lipoids, lecithin, especially cholin, evolve.

The question is rendered still more difficult by the toxic action of these substances, which leads to metabolic disturbances, to alteration of the sympathetic system and to changes in blood pressure and blood constituents. We probably should attach less importance to those changes which are transitory than to those which are manifested for a long time after irradiation.

Pordes recently proved the existence of leucocyte destruction which had been denied in man and this even in small anti-inflammatory doses which represent only a small fraction of the anticarcinomatous dose. But we must leave to further experimentation the task of determining if and to what extent those *artificial* immunizing processes are of value in influencing carcinoma of man.

As we know relatively little of this radiological immunity in man, and as the methods which are based on it do not give the same results as in animals, it is more reasonable to attach the rôle of the highest importance to *natural* immunity. Based on the spontaneous healing described by Czerny, Ewing, Sauerbruch, Ceelen, Orth,

Schmidt, Lubarsch and others, Opitz has insisted several times on the existence of this natural immunity. Recall that youth signifies almost always an absolute immunity and that recent studies have shown without the slightest doubt the existence of a hereditary predisposition to cancer (Slye, Wachtel, Kaiser, Paulsen and others). Drew of the British Imperial Cancer Research Foundation has isolated from cancerous tissues a substance which favors the growth of other tumors and which is inhibited by normal serum, a fact which furthermore favors the existence of antibodies in the serum.

We may mention also the fact that metastases are produced most often in those organs rich in lactic acid, especially in the liver. They are, on the contrary, rare in the organs poor in this substance, as, for example, in the muscles and in the spleen.

Now arises the question as to the nature of these protective substances or processes. The diminution of endocrine activity with age makes us think that a definite rôle may be attributed to the hormones. But conclusive experimentations for the proof of this are limited. The experiments on artificial tumors due to tar have shown that their growth might be arrested or inhibited by pituitary extract. In animals without ovaries, testicles or spleen, there was found no modification of the growth. On the contrary, the growth of tumors was found greatly increased during gestation and large tumors were observed to disappear during lactation. Insulin has given contradictory results. Adrenalin and glucose have increased the growth (Seel, Parodi, Kratkina, Muenzer, Ralph and Rupp).

The fact that Buschke could produce papillomata in the stomachs of rats, by the rectal administration of thallium—papillomata similar to those which Fibiger has produced with spiropters—also speaks in favor of the importance of the rôle of the endocrine system. Buschke proved, in fact, that thallium produces an alteration in the endocrine function, an alteration which may be made to recede in part by the administration of thyroid or thymus extract.

I have not been able to find any reference in the literature to systematic clinical researches made on man. The systematic observation of the effects on man of endocrine preparations combined with irradiation seems to me to be an important work to be carried out in the future. I have myself begun to combine thyroidine with radiotherapy. Future experiments will have to determine if a positive result obtained with such a combination of hormone and roentgen rays is due to a direct action on the tumor, or if it is only an aid in the process of oxidation, whereby the insufficiency of this oxidation process plays a rôle in the production of neoplasm, as Otto Warburg has suggested.

3. In the normal cell, according to Warburg, the glucose is oxidized, for the most part, and only a very small quantity is transformed by fermentation into lactic acid. In the carcinomatous cell the opposite occurs and Warburg could reproduce its metabolic process by asphyxiating normal growing cells. The larger number of these cells die by this process, because their resistance to diminished oxygenation is very weak. But those which, like cancer cells, can live a long time without oxygen, remain alive and their metabolism resembles that of the cancer cells: that is to say, fermentation occurs and is followed by lactic acid formation. As growing is no longer limited by oxygen, proliferation without order occurs as in cancer.

Along the same line, Carrel was able to produce sarcoma in chickens by the injection of arsenious acid, the effect of which was to inhibit cellular oxidation, without interfering with the fermentation processes. It is only a step further to conclude that normal oxygenation in tissues represents a protective function which inhibits the formation and growth of tumors. The rôle of irradiation would then be to raise the vascular permeability for the oxygen, for oxidative ferments or other catalyzers. This is the more probable, since Kondratjew has proven that in plants oxidation as well as reduction was augmented by radium.

The experiments of Cramer on this subject seem to be especially important. He found an immediate decoloration on irradiation of the mesentery of the frog (1/3 H.E.D.) stained during life and

examined under the capillary microscope. On repeating the staining three weeks later, but without further irradiation, the accelerated disappearance of the stain again appears. The decoloration is due, without doubt, to an oxidation process, because it is directly dependent on a sufficient blood supply and when the blood-supply is cut off by a tension ligature, the reaction is inhibited, but hemorrhage greatly augments it. It was further observed that this phenomenon could not be produced during the frog's hibernation period, during which, because of a change in the thyroid secretions the oxidation processes are reduced to a minimum. Cramer expected to cause the reappearance of the reaction by the administration of thyroid extracts.

Kondratjew as well as Cramer insists on the importance of the rôle of iron as a catalyzer.

Further, the experiments of Schwarz and Holthusen favor the importance of oxidation in irradiation. They demonstrated that in anemia artificially produced in tissues by temporary ligature no reaction to irradiation was produced until the blood supply to the tissues was restored.

Petry proved that no radiologic reaction was produced in an atmosphere free of oxygen and Poos proved that no alteration occurred in the spleen of Cohnheim's frog kept alive by artificial circulation of salt solution, but in the normal spleen with blood circulation, the spleen itself was reduced to half of its normal size.

Finally, the investigations of the Danes, Fischer and Andersen have proved that not only oxygen, but also its pressure and some other factor are of great importance. They showed that malignant cells die at a lower pressure than normal cells. Cancer-mice were kept in pure oxygen under a pressure of 1.6–2.0 atmospheres, after which procedure in several animals the tumors began to suppurate. The pus perforated the normal skin one day later and the tumors disappeared completely. In other animals complete resorption of the tumors occurred. Tumors which did not necrotize reduced the growth. Sometimes recidives were found. But the treatment with oxygen did not have any effect if it was not preceded by the application of some catalyzer—copper or selenium—and it seems reasonable in connection with our theory, to suppose that they play the rôle of making the vessel walls permeable to oxygen, as the pressure only increases the absorption of oxygen by the blood. As the investigators say, they have not yet found the conditions of infallible healing. So it will be important to investigate also the rôle of permeability and to repeat the experiments in animals and men which are under the strong effect of roentgen rays or radium.

In connection with this subject, we may also mention another possibility. As shown by the work of Desjardins, the discussion on the direct irritative action of roentgen rays, that is to say, on the value of the fundamental law of Arndt-Schulz, is not yet determined. Hyperpigmentation seems to me to be the only phenomenon of excitation which has not yet been proven to be indirect. The pigment is, as we know, produced by an oxidase which Bloch was able to determine by dioxyphenylalanin (dopaoxydase). Pincussen found, that the action of all the ferments is inhibited by irradiation, but he could not confirm the phenomenon as regards oxidases, the activity of which is, on the contrary, augmented by roentgen rays. Stoklasa also demonstrated that the alpha rays stimulate the activity of oxidation ferments, increasing the oxidation processes. It is therefore reasonable to assume that roentgen rays have a direct favorable action on the dopaoxidase, as well as on other oxidases and that this phenomonon plays its rôle in the healing of neoplasms.

The preceding could explain why the growth of malignant tumors is not stimulated by irradiation in small doses, as is the case, for example, in pathological granulations. As we know that any dose inhibits fermentation and activates oxidation, there can only result a favorable effect on tumors in the sense of a diminution in its volume. As I have shown in a preceding article on the use of small continued doses, the practical observations favor this view point. Starting with the preceding considerations we may deduce

as the immediate task of our therapeutic technique:

1. A dose of roentgen rays and radium conducive to a hyperemia and an increase of the vascular permeability as lasting as possible without producing a lesion of the vessel walls which might render them incapable of reacting to subsequent irradiations, which might be eventually called for. The technique indicated by Anschütz of Kiel for carcinoma of the breast conforms to this postulate (8 times $\frac{3}{4}$ E.D. during one year). Further experimentation must be done to determine the minimum dose necessary to the production of vascular permeability. Cramer obtained a decoloration of trypan-blue in a period of three weeks with $\frac{1}{3}$ E.D. in the frog and the results I obtained with repeated small doses in man prove that even smaller doses may be sufficient. It occurs to me also that the very small anti-inflammatory doses of Heidenhain and Fried cause an alteration of permeability favorable for its effect.

2. Systematic combination of irradiation with the administration of substances capable of activating oxygenation in the tissues, at the same time inhibiting fermentation and tending to neutralize the acidity. I give thyroid extract, iron and alkalies to the point of alkalinizing the urine. Referring to thyroid extract, it is proven that it increases metabolism and it especially increases oxygen absorption and leads to an activation of the catabolic processes. We have already mentioned the rôle of iron as a catalyzer in oxidation.

If our conclusions are correct, they allow for the first time a satisfactory explanation of the apparently paradoxical fact that roentgen rays can produce and cure carcinoma at the same time. In 1918, Holzknecht published 50 cases of hyperkeratosis and radiologic cancer which were healed by irradiation. He stated that radiologic keratosis arises in a chronically altered skin with the aid of a still unknown factor which is the objective of research on cancer.

We have known for a long time that the chronic action of roentgen rays produces fibrosis of the vascular wall, and Siedamgrotzky proved that continued irradiations diminish the permeability permanently. What Warburg produced artificially must occur in fact. The cell is asphyxiated. The hydrocarbon combustion is transformed in fermentation and the growth, no longer controlled, begins. But Siedamgrotzky further proved that the impermeability is only relative and that a new erythema dose leads to a new edematous transudation from which results an increased gaseous interchange and an inversion of the processes cited above. Experiments of Liebersohn and Schimanko prove that doses below a certain limit have an effect on the tuberculin reaction different from that of larger doses. So it seems very probable that in inflammation small doses increase the impermeability of cells and vessels. The clinical fact that fever falls rapidly and that the general state immediately improves, speaks in favor of this opinion. Accelerated suppuration is well explained by a consequent increase of the concentration of toxins and spontaneous resorption by a consequent increased formation of antibodies.

Such an antagonistic mechanism in healing of cancer and inflammation is also suggested by the fact that tar heals eczema madidans but produces cancer, causing in both cases the same effect, that is to say, increasing the impermeability of cell membranes.

Dujardin, on whose earlier experiments this theory is based, in a recent work on inflammation and cancer, develops a theory which is just contrary to this one. He supposes that the vascular walls, normally impermeable, are made permeable to a filtrable virus by chronic inflammation. But the existence of such a virus is only proven in the Rous sarcoma of chickens and not in carcinoma of man. And further, we see cancer so seldom after the healing of recurring eczema madidans, which is exquisitely hyperpermeable, that it seems more reasonable to think of a direct immunization against cancer by patients predisposed to eczema.

This conception is confirmed, on the one hand, by the healing of radiologic cancers reported by Tillman, by the injection around the tumor of the blood of the patient, an artifice by which the vascular walls are disregarded and the blood directly placed

in contact with the cells. On the other hand, it is confirmed by the findings of Bucky, who healed carcinoma of the skin with very light penetration rays which were absorbed only by the superficial layers. But the superficial erythema dose suffices to produce layer by layer even to the deeper ones, the reestablishment of normal metabolism. The temporary results of Rahm obtained by the sympathectomy can be explained also by a change of permeability, a change which disappears with the rapid regeneration of the nerves.

Furthermore, the theory of the etiology of cancer could be cleared by these conceptions in the sense that permeability forms a bridge, so to speak, between the results of Warburg and those of the older researches on cancer. Parasites and microbes have been found in animal and in man as the agents of cancer. Fibiger was first to produce sarcomatous lesions by means of parasites. Rous produced sarcoma of chickens by the inoculation of a virus filtrate without cells. Teutschlaender proved that the causative principle of this tumor is a ferment derived from cells. We have known for a long time that chronic irritations of mechanical, physical, chemical and biological nature are related to the etiology of cancer formation. The same applies to tuberculosis, syphilis and scar tissue. But Brandes stated in his recent collective study, that chronic irritation alone is insufficient to explain the question, but that an element still unknown to us plays its rôle. The connecting link of all these etiological factors, apparently so divergent, may be found in the chronic alteration of vascular permeability to natural antibodies, or in other words, in a slow asphyxia of the cells. Likewise, the fact that one injection of a cubic centimeter of filtrated virus is sufficient to produce a tumor, rests within the limits of our comprehension. In fact, a cellular ferment can easily directly produce the same result, which was produced by the arsenious acid, utilized by Carrel, namely, a suppression of oxidation.

The special activity of roentgen rays and of radium against a process with so varied an etiology, is well explained by the fact that we have no other means capable of raising the vascular permeability for such a long period and to such a marked extent, without producing accessory effects of a harmful nature.

But we also understand the uselessness of radiotherapy when the tissues adjacent to the tumor do not possess blood vessels and when a new formation of capillaries in them is made impossible by natural or pathological conditions, or when previous irradiations have produced an irreparable impermeability of the vessels.

Warburg says, referring to further investigations, "The problem of cancer etiology is the problem of the cause of the changes of metabolism in cancer tissues."

The investigations of the differences and alterations of permeability in the several tissues and tumors will play an important rôle.*

* After completing this study, I found in the literature a publication of Kaiser (Berlin) which reports very favorable results obtained in 3 cases of inoperable tumors by the use of thyroidine. Kaiser based his opinion especially on the idea that carcinoma is never found in cases of hyperthyroidism. But Secher (as cited by Parrisius) found a cancer of the pancreas at the post mortem examination of a case of Basedow's disease.

A COMPARATIVE STUDY OF DOSAGE TECHNIQUE IN RADIATION THERAPY

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AT a meeting of the Philadelphia Roentgen Ray Society about a year ago, methods of giving more accurate dosage in radiation therapy were discussed. We mentioned at that time the importance of making use of the physical laws governing irradiation in the routine treatment of patients. I am glad to report the progress that is being made in a group of roentgen-ray laboratories in Philadelphia, and a number outside of Philadelphia, in the application of physical factors in the routine treatment of each patient. Patients are studied with the idea of obtaining a diagram of the location of the tumor and the course of irradiation is mapped out in detail in order to obtain as nearly as possible the desired tumor dose with the smallest possible amount of radiation to any one skin area, or port of entry.

Physical measurements of radiation are being worked out to a rather high degree of accuracy and will soon be standardized. The progress in radiation therapy will not come from any new physical measurements, or the discovery of any new physical factors, but must come from the application of known physical measurements to the treatment of each patient.

The question of how any particular roentgen-ray laboratory is going to apply in a practical way these physical factors is a matter of properly organizing the work. Nurses, or technicians can be taught to do about 90 per cent of the detailed work. This fact is demonstrated by the group of roentgen-ray laboratories routinely applying these methods. Roentgenologists in a great many instances avoid the use of physical measurements because they are unable to understand them. If the work is organized by a physicist, and nurses and technicians taught to carry on with their part of the work, there is no reason why each roentgen-ray laboratory cannot apply physical factors 100 per cent. The progress that has been made in the last year makes me feel optimistic for the future of radiation therapy providing scientific work is done. If we go on in a hit and miss manner in the administration of radiation, radiation therapy will advance very little over what it is today. How many roentgen-ray laboratories today know what is being done elsewhere except in a very hazy way? We are striving to overcome this radiation therapy isolation by organizing a group of laboratories here in Philadelphia and elsewhere. Just consider the advance made in roentgenography during the last few years. What has been the medium of exchange of ideas? It has been the roentgen-ray film. If a roentgenologist gets an interesting or puzzling case he demonstrates the films before some roentgen-ray society for the purpose of gaining, or giving information. What have we today in radiation therapy to give us a complete diagram of our patient and the course of treatment to compare with the film in roentgenography for information? This is the question we are attempting to answer.

It has been our thought to coördinate the work in such a way that each roentgen-ray laboratory can accurately know the techniques used in other laboratories. Our procedure is as follows:

1. The radiation intensity of each roentgen-ray machine has been measured and compared to radium as a standard.

Figure 1 shows a schematic drawing of our standardization apparatus. Restandardization measurements are made twice a year and oftener if the constants of the equipment have been changed. Our erythema value for 200 kv., 0.5 mm. of copper and 2 mm. of aluminum as filters, 50 cm. skin target distance, with a field 20 cm. in diameter is 2200 e units, taking into account the scattered radiation from the tissue.

To obtain the same intensity of 2200 e units, various installations will require from 350 to 400 ma-min. The above dosage of radiation produces a definite erythema on the average patient. There seems to be no reason for increasing the filtration over 0.5 mm. of copper. Penetration measurements of radiation in water passing through 0.5 mm. of copper as compared to 1 mm. of copper gives only a fraction of a per cent more radiation reaching 5, 10, and 15 cm. depth for the more heavily filtered radiation. However, the skin intensity of radiation filtered by 1 mm. of copper is only about 70 per cent of the skin intensity filtered by 0.5 mm. of copper. This means that the number of milliampere-minutes to produce an erythema with a filter of 1 mm. of copper must be about 30 per cent greater than for 0.5 mm. of copper. The increased time factor for a given output of radiation intensity does not justify the very small increase in penetration.

2. Each roentgen-ray machine has a continuous reading iontoquantimeter[1] permanently attached to the tube holder. This iontoquantimeter insures a constant output of radiation and warns the operator immediately if a filter has been omitted.

Figure 2*a* shows an ionization chamber attached beneath the porthole of the tube holder. The ionization chamber can be attached to any tube holder. A pointer attached to the ionization chamber gives the center of the field and the perpendicular distance to the patient. The pointer is removed after the patient is placed in position. The ionization chamber is attached to a galvanometer as shown in Figure 2*b*. The reading of the galvanometer is projected on a ground glass scale (Fig. 2*c*) by means of a lamp, prism and mirror. The operator can observe the reading on the scale while watching the patient.

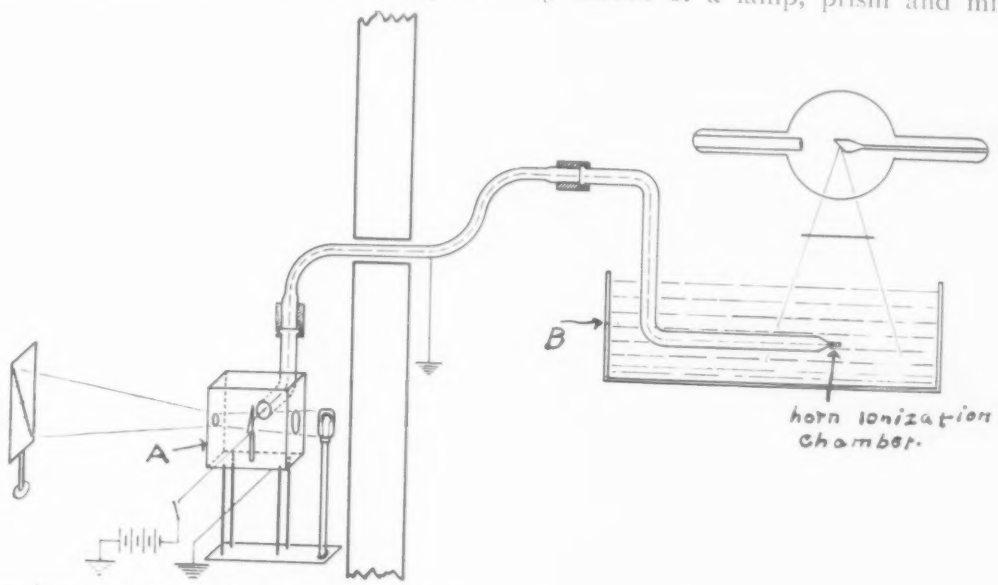

FIG. 1. Apparatus for standardizing roentgen-ray equipment and measuring depth penetration. "A" is an electroscope connected by a flexible cable to a horn ionization chamber. "B" is an aluminum tank with ¼ inch of rubber vulcanized on inside filled with water which is made in size to represent the patient.

3. Our method of charting a patient is as follows: We choose from a series of Desjardins' anatomical charts (Fig. 3) the chart showing the cross section passing through the center of the tumor.

The charts are reproduced on lantern slides 4¼ by 6½ inches. The slides are enlarged to the anteroposterior and lateral dimensions of the patient by a kodak autofocuser (Fig. 4).

A sketch of the cross-section is made on the paper at "A." The tumor area is given a location with boundaries showing as nearly as possible the distance from the skin in two directions.

4. Curves have been made of the penetration of radiation in water by ionization measurements.[3,4] These curves have been reproduced on celluloid in three different colors—red, yellow and black. Two or three sets of these curves are placed over the cross-section and the location, size and number of fields decided upon by observing the total percentage of radiation reaching the tumor area. Our main object is to get as much radiation into the tumor area with the smallest possible quantity of radiation over any one area, or port on the skin. It is our firm belief that we must deliver sufficient radiation into the tumor area in order to obtain the best results.

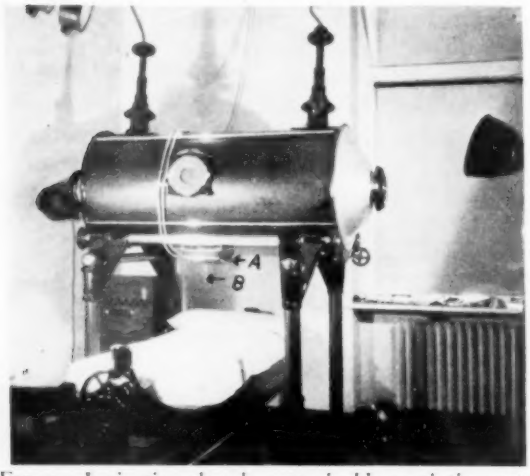

FIG. 2a. Ionization chamber attached beneath the port-hole of the tube holder. A is a rectangular ionization chamber. B is a removable pointer.

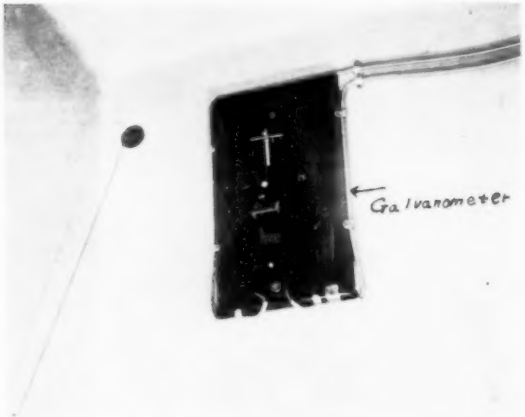

FIG. 2b. Galvanometer to which ionization chamber is attached.

Part A, Figure 5, shows the curves placed over the cross-section in the process of locating the ports of entry and direction of the center of the field of radiation. Part B, Figure 5, shows the cross-section drawn up to act as a guide in giving treatments to this particular patient.

FIG. 2c. Ground glass scale for reading galvanometer.

This may seem to be too much work. The amount of time and energy consumed in charting the patient properly actually saves time in the end. Most of us are giving some form of divided dosage for each area on the skin. If the fields are marked off on the skin of the patient according to the chart, treatments are given quickly and accurately without the necessity of making another study of the patient for each treatment. There is a great deal of satisfaction in knowing that you have accurately directed the radiation and knowing the percentage delivered to the tumor. The diagram and record of a given treatment provides a medium of exchange of ideas as it allows one to visualize the entire procedure, and gives a complete summary of the treatment at a glance. The diagrams are valuable records in a legal dispute.

Part B, Figure 5, shows the fields located with direction and percentage of radiation reaching various parts of the cross-section. These percentage values at different points were obtained by noting the sum of the

percentages where lines of the depth penetration curves cross, as shown by Part A, Figure 5. The intensity is quite well distributed throughout the whole area, reaching about 120 per cent of the skin intensity in the tumor tissue for this particular patient. There are areas to be protected between the two ports of entry anteriorly and between the two ports posteriorly. If strips of lead are laid on the patient, as shown in Part B, Figure 5, the edge of the lead being kept parallel to the direction of the roentgen rays, these areas will not be over-irradiated.

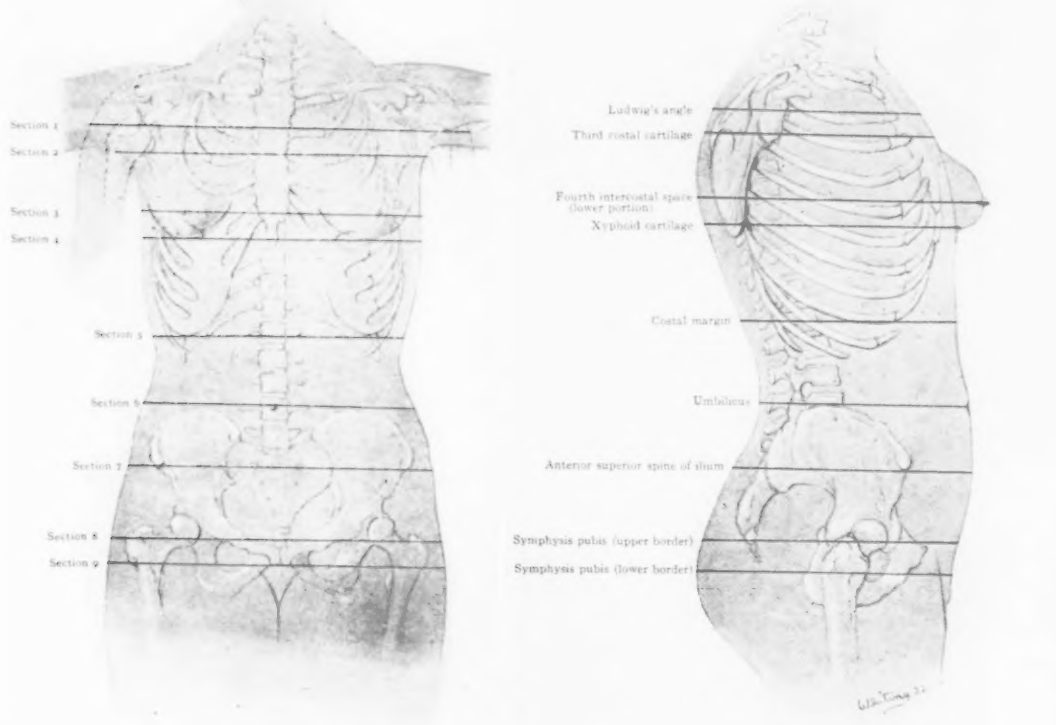

FIG. 3. Showing the relative position of each anatomical cross-section in the female, as reproduced by Desjardins.

5. We have been irradiating patients with two definite techniques: The saturation method as first suggested by Kingery[5] for skin therapy and later worked out by Pfahler[6] for superficial and deep therapy; and then the divided dose technique given daily, or twice daily as suggested by Regaud and followed by Morgan.[7]

Part A, Figure 6, shows the logarithmic curve suggested by Pfahler as representing the progress of roentgen-ray reaction going on in the tissues. This curve was obtained by clinical observations assuming that half of the roentgen-ray reaction was dissipated in a given length of time, and half of the remainder in the same length of time, etc. We substituted the values for the various intensities in the equation representing such curves as follows:

$$I = I_0 e^{-\mu d}$$

Where I = Intensity at any point.
I_0 = Intensity at the beginning.
μ = Coefficient of absorption, or quantity of roentgen-ray tissue reaction going on per unit of time, in this curve per one day of 24 hours.
e = Base of the Naperian logarithm system.
d = Period corresponding to intensity I.

Solving the equation by the use of logarithms,

$$\begin{aligned} \text{Log } I &= \log I_0 + \log (e^{-\mu d}) \\ &= \log I_0 + (-\mu d) \log e \\ &= \log I_0 - \mu d \log e \end{aligned}$$

$\log e = 0.4343$. By substituting in above equation,
$\log I = \log I_0 - \mu d \times 0.4343$.

The above equation is now in a form in which it is easily solved if one has a little knowledge of logarithms. Our graduate students in radiology learn to solve this equation quite readily. We are, therefore, confident that any roentgenologist can learn to do the same. We computed from Pfahler's saturation curve the coefficient of absorption by the tissue of roentgen radiation to be 0.055. The equation then becomes,

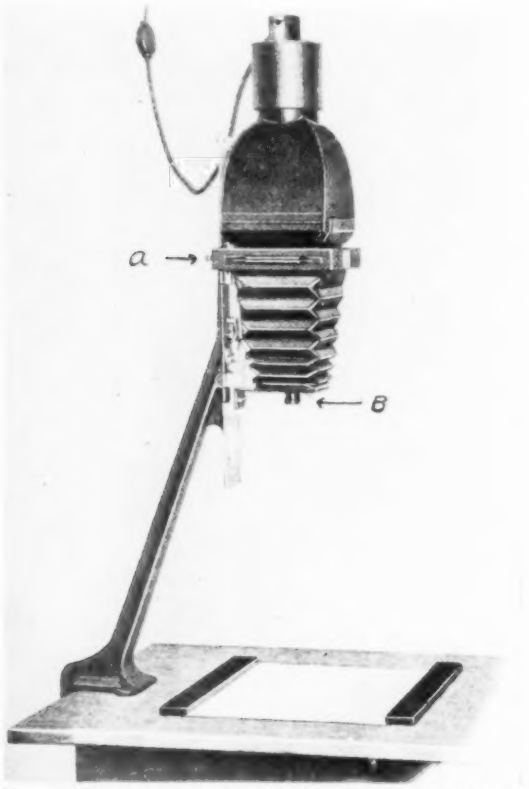

Fig. 4. Showing the auto-focusing device for enlarging anatomical cross-section lantern slides to coincide with the dimensions of patients being treated.

$$\text{Log } I = \log I_0 - 0.055 \times d \times 0.4343$$

If 0.055 represents the absorption coefficient of roentgen-ray tissue reaction, then knowing the initial intensity, the intensity of radiation left in the tissue at any time can be computed from the above equation.

In order to facilitate the use of the saturation method, where a knowledge of the methods of obtaining the curve is not known, a table has been worked out using the factors of 400 ma-min. as the upper limit for a full erythema value and giving the number of milliampere-minutes lost in roentgen-ray tissue reaction from one to five days inclusive. This table means that if 100 ma-min. of roentgen radiation be given to a patient, operating the roentgen machine at 200 kv. (peak), 0.5 mm. of copper plus 2 mm. of aluminum as filters and 50 cm. skin target distance, two days after the radiation had been delivered to the patient, there would remain in the tissue 90 ma-min., or 10 ma-min. have been used in roentgen-ray reaction. In four days' time, 20 ma-min. have been used in tissue reaction, leaving in the tissue 80 ma-min. of potential roentgen radiation. Of the 190 ma-min., 20 ma-min. would be used in the tissue producing roentgen-ray reaction in twenty-four hours, etc. Irradiation is given daily, or every other day, determining the loss between treatments in milliampere-minutes and deducting same before a new treatment is given. This procedure is followed until the tumor tissue is fully saturated with an erythema dose. Any one port of entry must not receive more than a saturation dose and less if the irradiation can be delivered to the tumor by a number of different ports of entry. When the saturation point is reached, the loss in milliampere-minutes for 400 ma-min. is figured for every three days, which is 58 ma-min. This quantity of radiation is delivered again into the tumor tissue to maintain the involved area at a saturation point, until at least two full erythema doses in terms of milliampere-minutes have been delivered into the tumor over a period of four to five weeks.

6. Let us again observe Part B, Figure 5, in deciding how one will give the radiation in order to do as little harm as possible to skin and fatty tissue through which the radiation must pass. If it is decided to use the saturation method in treating the patient, it is necessary to decide how fast one will bring the tumor tissue to saturation. It is seen that by the use of four ports of entry, 120 per cent of any one skin intensity is reaching the tumor, providing the same skin intensity is given each port, every day. This means that each

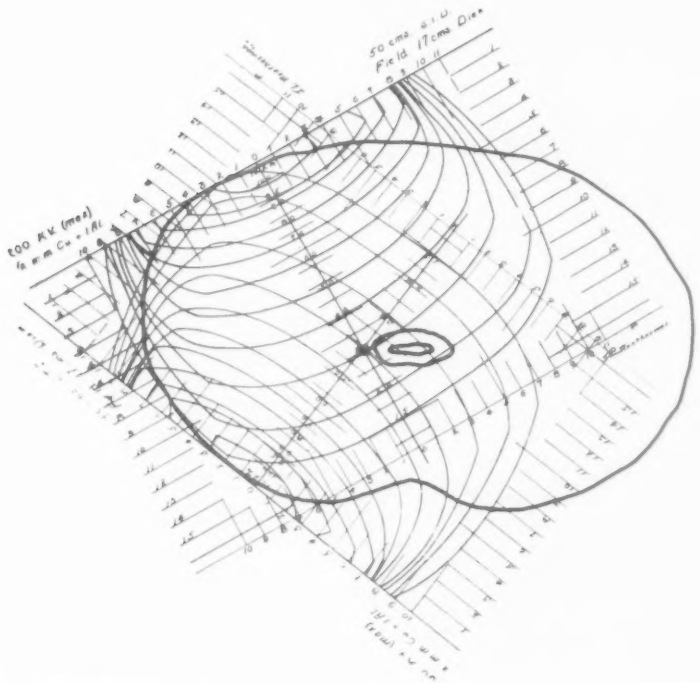

FIG. 5, PART A. Arranging the different ports of entry and the direction of radiation to desired depth dosage. Shows depth penetration curves placed in position over half the cross-section.

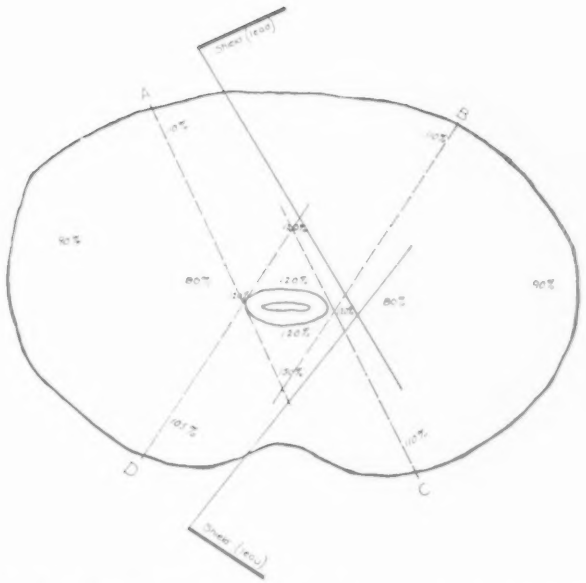

FIG. 5, PART B. Arranging the different ports of entry and the direction of radiation to desired depth dosage. Shows ports A, B, C and D and the direction of the center of the field. It also shows the lead plates placed in position in two of the fields.

skin area will not receive more than about 90 per cent of a saturation dose.

We are all very much concerned to get as much radiation into the tumor with as little skin reaction as possible. Are we going to give 200 ma-min. over each area every fourth day, or are we going to give 50 ma-min. over each area every day? The intensity of radiation produced by 200 ma-min. every fourth day on any one skin area will produce a more intense erythema than 200 ma-min. distributed equally over four skin areas administered daily. Will the tumor area receive as much radiation daily by applying an intensity produced by 50 ma-min. to each one of the four ports of entry every day as 200 ma-min. administered to port A the first day, port B the second day, port C the third day and port D the fourth day, returning to port A on the fifth day? Following the technique of giving 50 ma-min. daily over each of the four ports of entry, about 30 per cent of the skin intensity from each port of entry (Part A, Fig. 5) reaches the tumor, or an equivalent skin intensity produced by 15 ma-min. from one port of entry. Since there are four ports each

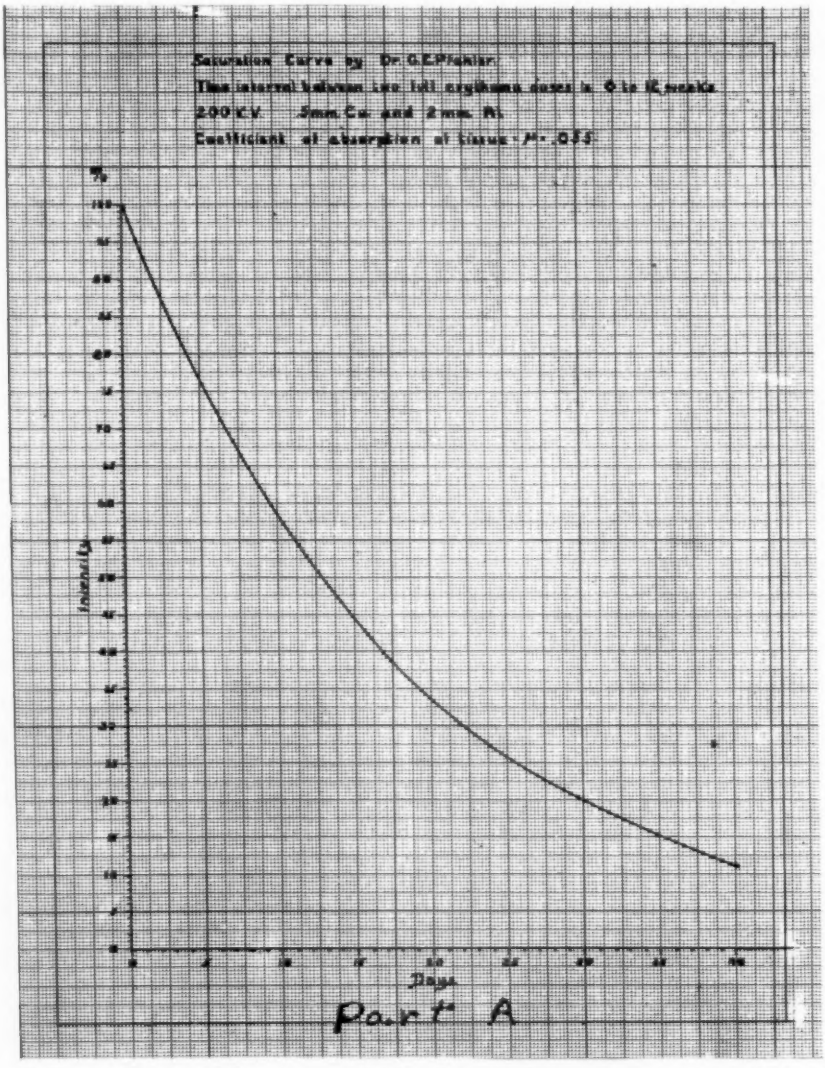

Fig. 6, Part A. Exponential curve representing the rate of roentgen-ray reaction in the tissue.

delivering 15 ma-min. of skin intensity to the tumor area, the total intensity delivered daily to the involved area is equivalent to 60 ma-min. of the skin intensity each day. If each port of entry is irradiated with an intensity produced by 200 ma-min. on succeeding days, taking four days for a cycle, the radiation delivered to the involved area each day will be 30 per cent of 200 ma-min. equalling 60 ma-min. of the skin intensity delivered to the tumor area. Therefore, the tumor tissue receives daily the same quantity of radiation following either one of the two procedures.

SATURATION CURVE LOSS IN MA-MIN FOR 1,2,3,4,5 DAYS WITH VARYING INITIAL INTENSITIES OF 200 KV — .5 MM CU. & 2 MM AL.

MA-MIN	LOSS				
	1 DAY	2 DAYS	3 DAYS	4 DAYS	5 DAYS
50	3	6	9	11	13
60	3	7	9	12	15
70	4	8	11	13	16
80	5	9	13	17	20
90	5	10	13	18	22
100	6	11	15	20	24
110	6	12	16	22	26
120	6	12	18	23	28
130	7	13	18	24	30
140	8	15	21	28	34
150	8	15	22	29	35
160	9	17	25	32	39
170	9	18	26	34	41
180	10	19	28	36	43
190	10	20	28	38	45
200	11	20	30	39	47
210	11	20	31	41	41
220	12	22	33	43	52
230	12	24	35	45	54
240	13	26	37	48	57
250	13	27	39	50	60
260	14	28	41	52	63
270	14	30	43	55	66
280	15	31	44	57	69
290	15	31	45	59	71
300	16	31	47	61	74
310	16	32	48	63	76
320	17	33	49	64	78
330	17	34	50	66	80
340	17	35	51	67	82
350	18	35	52	68	83
360	18	36	53	69	85
370	19	37	54	71	87
380	19	38	56	73	89
390	20	39	57	74	91
400	20	40	58	76	93

Part B

FIG. 6, Part B. Shows the loss of potential radiation from 1 to 5 days inclusive, for fractions of an erythema, where a full erythema value, or 100 per cent, equals 400 ma-min.

The advantages are that there is less skin reaction for a given tumor dose and a better distribution of radiation throughout the whole area. The disadvantage is that the nurse, or technician must rotate the patient four times during the treatment, which I believe is negligible.

Our usual technique in giving radiation according to the saturation method is to bring the patient to full saturation by giving from 50 to 75 ma-min., over each port of entry daily, except Sunday, until the tumor tissue is fully saturated, which is ten days to six days depending upon the daily dosage. The patient is treated every two, or three days, giving the patient the radiation lost in the time interval. This procedure is continued until at least two full erythema doses have been delivered to the involved area.

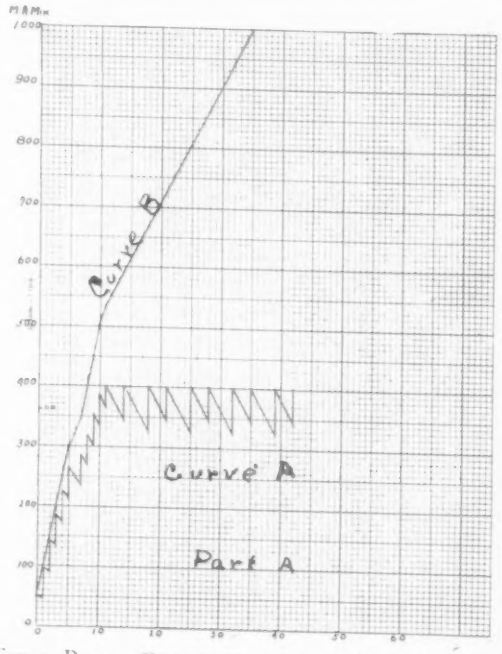

FIG. 7, Part A. Comparative method of keeping records of radiation given with time. Curve A shows the rate at which radiation is given, deducting the loss between treatments according to the saturation curve. Curve B gives the total amount of radiation given with time.

We are also irradiating patients with the Morgan technique[5] of small doses frequently given. This technique allows more radiation to be given to any port of the skin without damage to the skin. We have records of cases having received as much as 1700 ma-min. over a period of three months, our erythema value being 360 ma-min. The question of so many different ports of entry does not enter with this technique since the radiation is given in such small quantities.

If we are to make a comparative study of dosage techniques, we must have some means of scientifically studying the relative quantity of radiation reaching the tumors. Since Pfahler has given us a dosage

curve, in his saturation method, we find that we can express Morgan's technique in terms of Pfahler's curve. The same can be employed for any technique. The fact that we are able to express Pfahler's saturation method in a mathematical formula and show same by curves, makes it possible to show curves of comparative techniques.

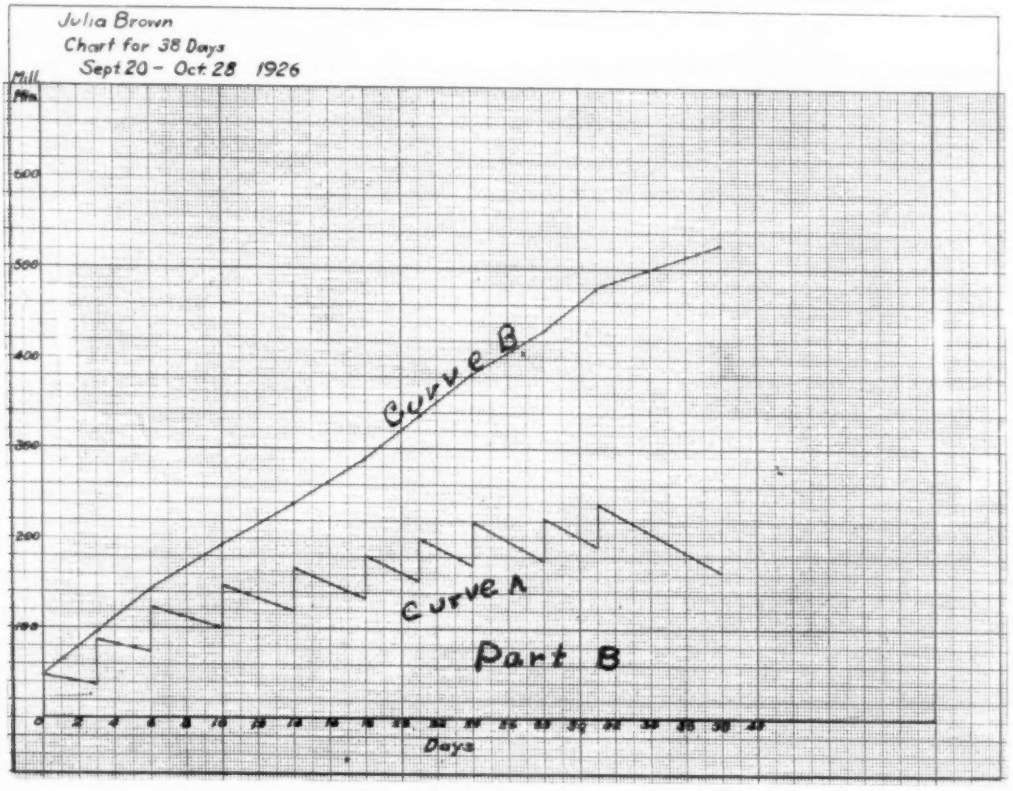

Fig. 7, Part B. Comparative method of keeping records of radiation given with time. Curves A and B are constructed in the same way but represent the small dosage technique. Comparisons can be made of the rate, percentage and total amount of radiation in one technique as compared with the other.

Figure 7, Part A, shows the method of keeping a record of the radiation given using the saturation method. The number of milliampere-minutes are plotted as ordinates, each small square representing 10 ma-min., while the corresponding time is plotted as the abscissa, each square representing one day. The initial treatment of 50 ma-min. is shown as zero time, Curve A. At the end of the first day, the irradiation had diminished to 47 ma-min., as shown by the downward slope of the line. The vertical line indicates the treatment at the end of the first day, making a total of 97 ma-min. of potential roentgen-ray radiation in the tissue at that time. At the end of the second day, the loss in roentgen-ray reaction for 97 ma-min. is 6 ma-min., the same being plotted for one day and shown by the downward slope of the line from the first day to the second day. The vertical line on the second day shows the additional radiation given at that time, making a total of 141 ma-min. The procedure is carried through as shown on the curve until full saturation is reached. If the tumor receives 120 per cent of the skin intensity, and a full saturation dose of two erythema values is delivered into the tumor, each skin area will receive less than two full erythema values and never become fully saturated. If one wishes to saturate the tumor tissue sooner, the quantity of radiation given to each skin area can be increased, and if it is not

feasible to treat daily, but every other day, it will be necessary to increase the dose from 50 to 75 ma-min.

Part B, Figure 7, shows a case treated by the divided dose technique and the quantity of radiation plotted according to the loss obtained from the logarithmic curve of the roentgen-ray tissue reaction for deep therapy. It is seen that during a period of thirty-five days, the patient received about 536 ma-min. and reached about 68 per cent saturation.

We are not in a position clinically to say which technique is the better. However, we can make a direct comparison of the quantity of radiation with time, as is shown by Parts A and B of Figure 7. These comparisons of the quantity of radiation delivered to the tumor area with the diagram are going to help us arrive at a more definite technique clinically.

We are indebted to Kingery and Pfahler for putting radiation therapy on a more standardized basis. Whether it is the true basis, time will tell. We can represent all of our radiation therapy in terms of the logarithmic curve, as was shown in the divided dose technique.

We have attempted to apply physical laws and measurements routinely in the treatment of patients, and the following recommendations seem essential:

1. Standardization of roentgen-ray equipment.

2. Installation of a continuous reading iontoquantimeter. This is not absolutely necessary to do scientific work but is useful as a guide and as a protection.

3. The application of anatomical cross-section charts for locating the tumor.

4. Application of the depth penetration charts to each patient.

5. Methods of keeping comparative records of different doses of radiation.

The above procedure has been of great value for the following reasons:

1. It conserves time in the treatment of patients.

2. It affords a complete diagram of the treatments given to each patient, and allows one to easily visualize the dosage employed.

3. It facilitates a direct comparison of different tumor doses employed in the treatment of malignancy.

This procedure is functioning satisfactorily in a group of roentgen-ray laboratories in Philadelphia and elsewhere, and our achievements are more than encouraging.

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EXPERIMENTAL WORK ON THE COEFFICIENT OF EXTINCTION OF ROENTGEN RAYS IN VARIOUS SUBSTANCES

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BUENOS AIRES

ACCORDING to the latest work on dosimetry of roentgen rays, in order to be able to define the mixture of rays quantitatively it is necessary to know the number of French or German roentgen units found at a given distance from the tube without any influence from reflected rays. Qualitatively all the other factors that have any effect at all on the composition of the bundle of rays must be taken into consideration. Different authors have shown that the coefficient of extinction in a substance is not enough to show the quality, but that the maximum tension in the tube and the kind and thickness of the filter used must also be taken into consideration. Some authors, particularly those of Dessauer's school, have shown these data experimentally in their works, and also the coefficient of extinction in water. For this they use water as a medium of absorption, as the phenomena of absorption and diffusion in water are similar to those of the human body. Other authors, for very good reasons, recommend defining the mixture by the coefficient of extinction in copper, or by the thickness of copper which decreases the intensity of the rays by half (Grossmann, Holthusen, Kuestner). These authors use copper because the greater atomic weight of this metal as compared with water causes greater differences in the coefficient even when the quality of the mixture is changed only a little and so experimental control is easier. Of course when the coefficient of extinction in copper is given the maximum tension in the tube and the nature and thickness of the filter must be given too. For these reasons work has been done with the object of determining theoretically and experimentally the various coefficients of extinction under certain conditions generally accepted in treatment. The differences in the results obtained by different experimenters, especially in studying the coefficient in water, were so great that we decided to repeat the determinations. We thought that our results would establish the true value of this coefficient more definitely because we have subjected it to the severest critical experimental examination.

1. *Determination of the coefficient of extinction in water.*

We will first review the works in which the coefficient in water has been determined. The oldest work, the results of which are in general use today in practice, was done in Dessauer's Institute (Frankfurt) and was confirmed in 1924 by the work of Lorenz and Rajewsky at the same Institute. Table A shows the values found.

TABLE A

Voltage in Kv.	Filter in Mm.	Dessauer and Vierheller	Lorenz and Rajewsky
		Coefficient of extinction	
152.1	0.5 Cu 1.0 Al	0.180	0.177
162.3	0.5 Cu 1.0 Al	0.166	0.166
179.5	0.8 Cu 1.0 Al	0.149	0.150
202.1	1.3 Cu 1.0 Al	0.140	0.141

The results obtained by other authors did not agree with these values, the differences sometimes being as high as 30 per cent. Glasser, for example, with 200 kv. (tension in the tube?), a filter of 0.75 mm. copper and 1.0 mm. aluminum and an effective length of 0.15 A, found that the coefficient of extinction in water was 0.18. This value is much higher than those given in Table A under similar conditions, for example a value of 0.15 with 179.5 kv., and a filter of 0.8 mm. copper and 1

mm. aluminum. Even assuming that the 200 kv. given by Glasser was the tension in the transformer so that the tension in the tube, taking into consideration the loss of tension in the rotatory rectifiers, was only 180 kv. more or less, does not explain the great difference in the coefficients (0.18 and 0.15). Nor do we think that this difference of about 20 per cent can be explained by the different distribution of the energy in the spectrum or lack of practical homogeneity as Lorenz and Rajewsky assume.

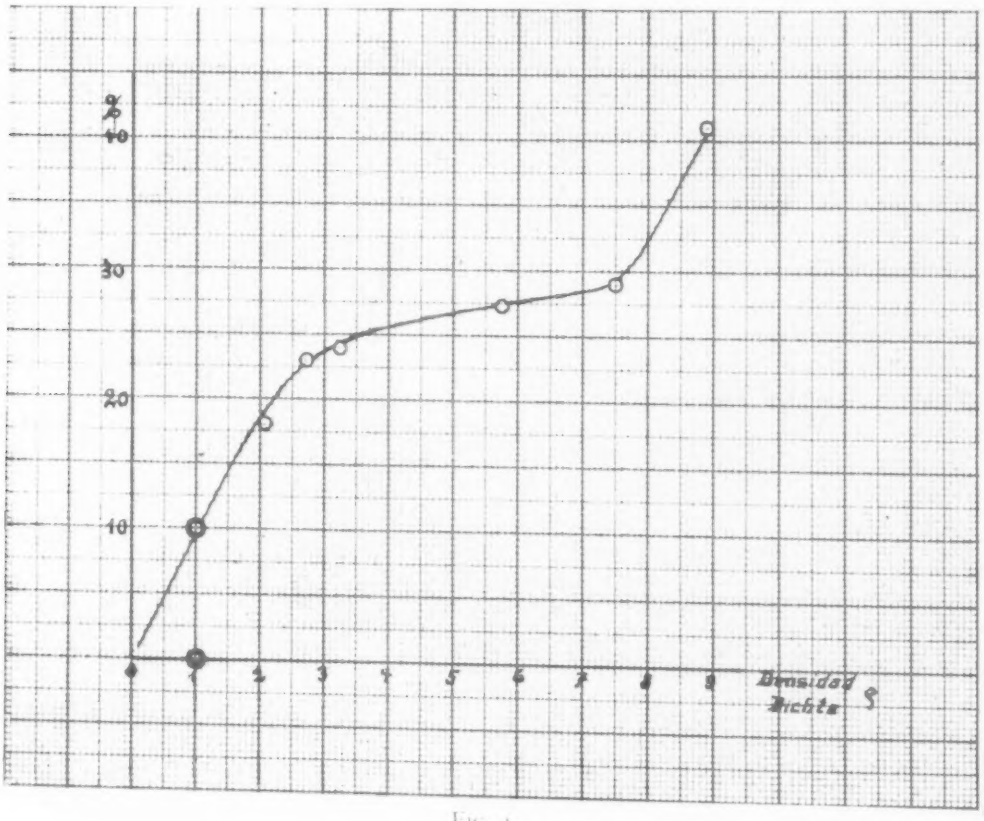

FIG. 1.

In 1922, a work by W. Statz appeared with a result very similar to that of Glasser. This author by a special experimental method found that with an effective length of 0.161 Å. the coefficient of extinction in water was 0.188. This result was confirmed the following year by Jaeger and Rump. These authors with an effective length of 0.16 Å. found a coefficient of 0.191.

According to these works the values of Glasser, Statz and Jaeger-Rump were in harmony and opposed to the results of Dessauer-Vierheller and Lorenz-Rajewsky. For this reason we examined the apparatus used in the experiments of the latter authors and believe that they did not take into account the glass of the vessel in which the water was contained in determining their coefficient. In order to determine exactly the effect of this glass and prove our theory we determined the degree of effect of glass on the coefficient of extinction of various metals, taking into account also the different densities of the bodies used.

In the technique of our experiments we made use of a Winawer electroscope modified by Dessauer and his students which does not have a bronze diaphragm in the metal tube. In the experiments in Dessauer's Institute these diaphragms were always used to overcome diffuse radia-

tion. But certainly the rays themselves whose intensity and quality are to be measured are the cause of a decrease of the coefficient by the production of characteristic rays. And there is another reason for the decrease in the result in the radiation of the walls of the electroscope at the point of exit of the rays. The external wall is of lead to avoid the direct rays passing into the air after they pass through the electroscope, and to prevent the diffuse rays which always exist in the observation chamber from having any influence on the discharge, which would happen if the latter were not well separated from the chamber where the roentgen tube is. Inside the lead there is a bronze plate to suppress the characteristic lead rays, and then a layer of aluminum about 1 mm. thick to absorb the characteristic rays of the bronze. There is also a thin layer of celluloid to prevent the corpuscular radiation (β) of the aluminum. We changed this construction of the electroscope to avoid the action of the diffuse rays in the inverse direction from the primary ray, which cannot be suppressed with this arrangement. To accomplish this we removed all the metal, leaving only the layer of celluloid. Before the rays enter the electroscope they have to pass through two small lead diaphragms in front of and behind the measuring filter. The diffuse rays from the exterior cannot enter the electroscope because the observation chamber is well protected against the diffuse rays which emerge from the tube (3 mm. wall). The natural discharge from the electroscope is absolutely negligible. The experiments were made with different milliamperages (5, 10, 15, 20) always with the same tension

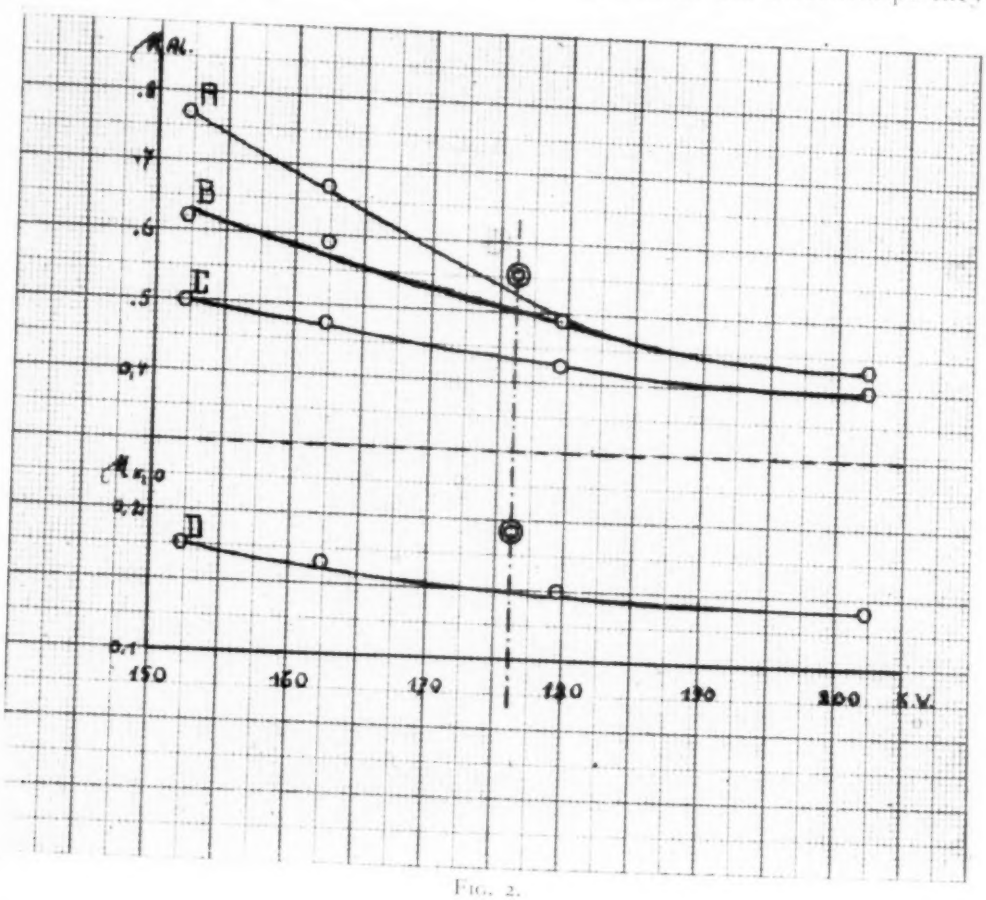

FIG. 2.

determined accurately beforehand with the spectrograph. We used as a generator a Neo-Intensiv apparatus (Veifa works) with condensers, using 176.3 kv. and 20 ma. with water-cooling. The filter was 0.5 mm. copper and 1 mm. aluminum.

The experiments were performed by two different techniques: (1) measuring the coefficients of extinction of the different substances shown in Table B; (2) determining the coefficients of the same substances adding to the primary filter (0.5 mm. copper and 1 mm. aluminum) the glass of the vessel mentioned above.

The values obtained by technique 2 were always less than those obtained by technique 1. Table B shows these differences in percentages of the values obtained by technique 2 (column 3). Column 1 shows the different bodies. The filters of copper and aluminum used were from the Veifa works and constituted the equipment of the electroscope. All the other substances used were products of the firm of Merck, Darmstadt, Germany. Column 2 shows the densities; column 3 shows the percentages by which the values obtained by technique 2 must be increased to get the true coefficients of extinction. The measurements were obtained with an effective length of 0.154 Å., 176.3 kv., and a filter of 0.5 mm. copper and 1 mm. aluminum. The walls of the glass vessel were plane and parallel and their total thickness was 5 mm.

TABLE B

1	2	3
Water	1.00	10.0
Sulphur	2.07	18.0
Aluminum	2.71	23.0
Barium nitrate	3.23	24.0

Figure 1 shows the graphic result. The values in column 3 of Table B are found in the ordinates of the graph and the corresponding densities in the abscissae of the system of rectangular coordinates. According to this curve an increase of 10 per cent in the value found according to method 2 corresponds to density 1 (water). In this way we found a value of 0.16-8 for the coefficient of extinction of water, using 176.3 kv. in the tube, a filter of 0.5 mm. copper and 1 mm. aluminum and the glass of the water vessel. This value has to be increased by 10 per cent, giving a value of 0.1846. We will compare this result with the values obtained in the work of Lorenz and Rajewsky.[2] The relation between the coefficient of extinction for water and the tension is shown graphically, always assuming that the rays used are homogeneous.

Curve D shows this relation. Our value, which corresponds to a tension in the tube of 176.3 kv. is larger than the corresponding value of Lorenz and Rajewsky. For this tension they found 0.152. Even adding to the coefficient of these authors the 10 per cent for the glass of the vessel, it is still less than ours. Taking into account the electroscope used by those authors we think that the secondary rays of the different parts of the electroscope (bronze diaphragm) are the cause of the lower coefficient obtained by Lorenz and Rajewsky, in addition perhaps to a difference in the quality and thickness of the glass used in the measurements.

2. *Determination of the coefficient of extinction of aluminum.*

This coefficient has also been determined by different authors and is mentioned especially by Lorenz and Rajewsky. Table C of those authors shows the values of curve A (Fig. 2) obtained by Dessauer many years ago, B those of the Veifa works and C the values of Lorenz and Rajewsky, considered by them as outside values. With our apparatus we found a value for the coefficient of extinction of aluminum $\left(\frac{\mu}{\delta}\right)_{Al}$ of 0.2054 with an effective length of 0.154 Å. (under the same conditions mentioned above).

According to the theory of Richtmyer with an effective length between 0.1 Å. and 0.2 Å. the coefficient of extinction of aluminum can be calculated according to the formula:

$$\left(\frac{\mu}{\delta}\right)_{Al} = 14.45 \cdot \lambda^3 + 0.15$$

If we substitute in this equation the value 0.154 Å. which in this case represents

λ, we get for $\left(\frac{\mu}{\delta}\right)_{Al}$ a value of 0.202⁷, which corresponds very well with the value which we found.

TABLE C
MEASUREMENT IN ALUMINUM

Voltage in Kv.	Filter in Mm.	Dessauer	Veifa Works	Lorenz and Rajewsky
		Coefficient of Extinction		
152.1	0.5 Cu 1.0 Al	0.77	0.62	0.507
162.3	0.5 Cu 1.0 Al	0.67	0.59	0.474
179.5	0.8 Cu 1.0 Al	0.49	0.49	0.429
202.1	1.3 Cu 1.0 Al	0.43	0.43	0.403

The values of the coefficient of extinction should be divided by $\delta = 2.7$ to get the coefficient of extinction of the mass.

3. *Determination of the coefficient of extinction of copper.*

For copper under the same conditions we got a coefficient of extinction $\left(\frac{\mu}{\delta}\right)_{Cu} = 0.7^{5}57$. This coefficient is very close to that obtained by Gaertner in his recent experiments; he found for the same effective length a value of 0.753.

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Publishers: PAUL B. HOEBER, Inc., 76 Fifth Avenue, New York City.

Twenty-ninth Annual Meeting: Kansas City, Mo., 1928. Date to be announced.

THE AMERICAN RADIUM SOCIETY

President: CURTIS F. BURNAM, 1418 Eutaw Place, Baltimore, Md.; *President-Elect:* EDWIN C. ERNST, St. Louis, M.; *First Vice-President:* BURTON, J. LEE, New York City; *Second Vice-President:* H. H BOWING, Rochester, Minn.; *Secretary:* G. W. GRIER, Jenkins Arcade, Pittsburgh, Penna.; *Treasurer:* ZOE ALLISON JOHNSTON, Pittsburgh, Penna.

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EDITORIALS

ANNUAL MEETING OF THE AMERICAN ROENTGEN RAY SOCIETY

The Twenty-eighth Annual Meeting of the American Roentgen Ray Society was held at the Mount Royal Hotel in Montreal on Sept. 20–23, 1927. The meeting was characterized by an excellent attendance of members and guests and by unusual interest in the scientific sessions. The social features including the "smoker" given by Dr. Pirie, the golf tournament, and the many dinners and other evidences of the hospitality of our Montreal hosts combined to make the meeting one of the most enjoyable the society has ever held.

The afternoon spent at McGill University listening to papers and witnessing demonstrations by Professor Eve and his associates was of unusual interest. Reproduction of original experiments upon the original types of apparatus was of real historical value and proved especially interesting to the younger roentgenologists. In startling contrast to this was Dr. Coolidge's paper on the same afternoon reporting his latest work on the production of cathode rays by extremely high voltages.

The annual banquet was held this year in honor of Dr. Coolidge who has long been an honorary member of the Society. The Society was particularly fortunate in having at this meeting not only Dr. Coolidge, whom it always delights to honor, but another member who in early years made one of the most important contributions to roentgen-ray apparatus, Mr. H. Clyde Snook, the inventor of the "interrupterless machine." For many years Mr. Snook has directed his energy to work in other electrical fields. It would be gratifying to roentgenologists if his attendance at the Montreal meeting and participation in its discussions were an indication of his intention to return to the field in which his efforts were so fruitful twenty years ago.

The 1927 Caldwell Lecture was delivered by Dr. G. W. C. Kaye, the distinguished English physicist and author who is director of the National Physical Laboratory. The lecture was on the subject "On Some Fundamental Aspects of Roentgen Rays" and included a general historical summary of the early work that led up to Roentgen's discovery, and a general statement of our present knowledge of the nature of the roentgen ray. All of this was but introductory, however, to what was the main theme of the lecture, the necessity for adequate protection of everyone exposed to the roentgen rays and a thorough discussion of the means of protection in use at the present time. The lecture will be published in full in an early issue of the Journal.

The following officers were elected for the coming year: President-Elect: E. H. Skinner, Kansas City, Mo.; Vice-Presidents: R. D. Leonard, Boston, and Lawrence Reynolds, Detroit, Mich.; Secretary: John T. Murphy, Toledo, Ohio; Treasurer: Wm. A. Evans, Detroit, Mich.; Member Executive Council: Willis F. Manges, Philadelphia; Librarian: H. W. Dachtler, Toledo, Ohio.

ENROLLMENT IN SECOND INTERNATIONAL CONGRESS OF RADIOLOGY

Anyone who contemplates attending the Second International Congress of Radiology should secure membership in the Congress by filling out the enrollment blank which will be found on page xv of this issue of the Journal and forwarding it with the required fee to the Secretary General in Stockholm.

The Congress Bureau informs us that it will undertake to engage rooms for Congress members in hotels, boarding houses and also, where this is particularly

desired, in private families. The rooms will be available to members at most favorable prices. Rooms in hotels will range between the following rates: 1 bed, 5–12 kronor; 2 beds, 8–23 kronor, with about double these prices if private bath is wanted. A number of rooms can be had in boarding houses or private families for about 4 kronor and up. Breakfast is not included in any of these prices. This will, as a rule, cost about 1 kr.

Those members who wish to avail themselves of the Congress Bureau in obtaining rooms should make application to the Secretary General stating the number of beds, the price, and whether or not he wishes private bath.

Early registration and request for accommodations will greatly facilitate the work of the Central Committee.

GEORGE E. PFAHLER,
President, American Committee
Second International Congress of Radiology

AMERICAN COMMITTEE FOR SECOND INTERNATIONAL CONGRESS OF RADIOLOGY

Notices have been published in the July and September numbers of this Journal announcing the Second International Congress of Radiology to be held in Stockholm, Sweden, July 23–27, 1928. The Central Committee in Stockholm of which Dr. Gösta Forssell is president and Dr. Axel Renander secretary general has appointed the following American Committee to have charge of arrangements for participation of the United States and Canada in the proceedings of the Congress: George E. Pfahler, Preston M. Hickey, Leopold Jaches, George W. Holmes, Edwin C. Ernst, Albert Soiland and A. C. Christie. The commitee met in Montreal on September 21, 1927, with six of the seven members present and in accordance with authority granted it by the Central Committee enlarged itself by the addition of the following to represent the societies named: Dr. A. H. Pirie, American Roentgen Ray Society; Dr. M. J. Hubeny, American College of Radiology; Dr. E. W. Rowe, Radiological Society of North America; Dr. Curtis F. Burnam, American Radium Society; Dr. E. H. Skinner, Section on Radiology, American Medical Association; Dr. Stanley Kirkland, Section on Radiology, Canadian Medical Association; Dr. Charles F. Stokes, American Electrotherapeutic Association. The following officers were elected: President: Dr. George E. Pfahler; Vice-President, Dr. A. H. Pirie; Secretary, Dr. A. C. Christie.

This committee is charged with recommending to the Central Committee all participants for the United States and Canada in the scientific program of the Congress. In order to secure the best possible representation from our countries the committee is requesting the presidents of all radiological organizations of national scope to send in recommendations of possible participants in the program. When these are received the commitee will carefully select those to be invited to participate in order to secure a proper division of the papers to represent the various subjects with which the Congress will occupy itself.

The committee is securing information with regard to transportation and will publish from time to time in the various official journals all information that comes to it regarding sailings, rates, and itineraries. The secretaries of the various national radiological societies have been requested to furnish to the different transportation companies complete lists of their members, and the companies will in turn get in touch with each member either through correspondence or through their local representatives. It has not been thought advisable for the committee to arrange tours for groups but it will be glad to cooperate in obtaining all possible information for any persons who wish to form groups either for the ocean trip or for visits to European clinics. Information with regard to itineraries under the direction of Thos. Cook & Son will be found on page 368 of this issue.

All communications should be forwarded to Dr. A. C. Christie, Secretary, American Committee, 1909 Massachusetts Ave., N. W., Washington, D. C.

GEORGE E. PFAHLER,
President, American Committee

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this column solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. John T. Murphy, 421 Michigan Ave., Toledo, Ohio.
Twenty-ninth annual meeting, Kansas City, Mo., 1928. Date to be announced.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. Fred M. Hodges, 801 West Grace St., Richmond, Va.
Annual meeting, Minneapolis, Minn., June 11–15, 1928.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. Robert J. May, St. Luke's Hospital, Cleveland, Ohio.
Annual meeting, New Orleans, La., Nov. 28–Dec. 2, 1927.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION
Secretary, Dr. E. C. Samuel, New Orleans, La.
Annual meeting, Memphis, Tenn., Nov. 14–17, 1927.

BUFFALO RADIOLOGICAL SOCIETY
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St.
Meets second Monday of each month except during the summer months, the place of meeting to be selected by the host.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. R. A. Arens, Michael Reese Hospital
Meets monthly on second Thursday from October to May (except during month of December) at Virginia Hotel. Dinner at 6 P.M., scientific session at 8 P.M.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, Dr. James H. West, 8314 Euclid Ave.
Meetings are held at 6 o'clock at the University Club, on the fourth Monday evening of each month from September to April, inclusive.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. Henry L. Ulbrich, 1130 E. Grand Blvd.
Meets monthly on second Friday from October to May, at Wayne County Medical Society Building.

CENTRAL ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. H. C. Kariher, Decatur, Illinois.
Regular meetings held quarterly.

NEW ENGLAND ROENTGEN RAY SOCIETY
Secretary, Dr. M. C. Sosman, Peter Bent Brigham Hospital, Boston, Mass.
Meets monthly on third Friday, Boston Medical Library.

NEW YORK ROENTGEN SOCIETY
Secretary, Dr. W. W. Belden, 8 West 16th St.
Meets monthly on second Monday, New York Academy of Medicine.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY
Secretary, Dr. D. S. Childs, 316 Gurney Bldg., Syracuse, N. Y. Three meetings a year—April, August and November.

PACIFIC COAST ROENTGEN RAY SOCIETY
Secretary, Dr. Harold B. Thompson, Seattle, Wash.
Two meetings a year.

ROENTGEN RAY SOCIETY OF CENTRAL PENNSYLVANIA
Secretary, Dr. W. E. Reiley, Clearfield, Penna.
Two meetings a year, April and October.

PHILADELPHIA ROENTGEN RAY SOCIETY
Secretary, Dr. Eugene Pendergrass, University of Pennsylvania, Philadelphia.
Meets monthly on first Thursday evening, Pennsylvania Hospital.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.
Secretary, Dr. S. C. Davidson, Highland Hospital.
Meets monthly on the first Friday evening at 7.45 at the Rochester Medical Association Building.

ST. LOUIS ROENTGEN CLUB
Secretary-Treasurer, Dr. L. R. Sante, Metropolitan Building.
Meets first week of each month. Time and place of meetings designated by president.

TEXAS RADIOLOGICAL SOCIETY
Secretary-Treasurer, Dr. C. P. Harris, Houston, Texas.
Annual meeting, Galveston, Texas, 1928.

BRITISH EMPIRE

BRITISH RÖNTGEN SOCIETY
Meets on the first Tuesday of each month from November to June inclusive, at 8.15 P.M., at the British Institute of Radiology, 32 Welbeck St., London; W. 1.

BRITISH INSTITUTE OF RADIOLOGY
Secretary, Dr. John Muir, 32 Welbeck St., London, W. 1.
Meets at 32 Welbeck St., but regular dates and times of meeting have not yet been arranged.

ELECTRO-THERAPEUTIC SECTION OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)
Meets on the third Friday of each month during the winter at 8.30 P.M. at the Royal Society of Medicine, 1 Wimpole St., London, W. 1.

RADIOLOGICAL SECTION, AUSTRALASIAN MEDICAL CONGRESS
Secretary, Dr. C. A. Anderson, The Hospital, Dunedin.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION
Secretary, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.
Meets monthly at Melbourne during the winter.

CANADIAN RADIOLOGICAL SOCIETY
Secretary, Dr. E. C. Brooks, Montreal.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION
Secretary, Dr. P. C. Fenwick, The Hospital, Christchurch.
Meets annually.

* Secretaries of societies not here listed are requested to send the necessary information to the editor.

CONTINENTAL EUROPE

BELGIAN SOCIETY OF ROENTGENOLOGY
Secretary, Dr. J. Boine, Avenue des Alliés, 134, Louvain (Belgium).
Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summertime.

ASSOCIATION OF GERMAN ROENTGENOLOGISTS AND RADIOLOGISTS IN CZECHO-SLOVAKIA
Secretary, Dr. Walter Altschul, German University, Prague, II/52.

DEUTSCHE RÖNTGEN-GESELLSCHAFT (GESELLSCHAFT FÜR RÖNTGENKUNDE UND STRAHLENFORSCHUNG)
Meets annually in April, alternating one year in Berlin, one year in some other German city. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.
Permanent secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.
Next meeting with the Gesellschaft deutscher Naturforscher und Aerzte will be in Hamburg, September, 1928.

SUD- UND WESTDEUTSCHE RÖNTGENGESELLSCHAFT
Meets annually in different cities.

NORD- UND OSTDEUTSCHE RÖNTGENGESELLSCHAFT
Meets annually in different cities.
Next meeting September 27, 1928, in Hamburg.

DUTCH SOCIETY OF ELECTROLOGY AND ROENTGENOLOGY
Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

SOCIETA ITALIANA RADIOLOGIA MEDICA
Secretary, Professor M. Ponzio, University of Turin, Turin.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD, USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs S. A. Reinberg and S. G. Simonson.
Meets annually.
Fifth Annual Meeting in Kiev, Ukraine, May, 1928.

LENINGRAD ROENTGEN RAY SOCIETY
Secretaries, Drs. S. G. Simonson and G. A. Gusterin.
Meets monthly on the first Monday at 8 o'clock in the State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky.
Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

SCANDINAVIAN ROENTGEN SOCIETIES
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with the exception of the Denmark Society, meets every second month except in the summertime:

SOCIETY OF MEDICAL RADIOLOGY OF SWEDEN
Meets in Stockholm.

SOCIETY OF MEDICAL RADIOLOGY IN NORWAY
Meets in Oslo.

SOCIETY OF MEDICAL RADIOLOGY IN DENMARK
Secretary, Dr. H. Scheuermann, Copenhagen
Meets on the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

SOCIETY OF MEDICAL RADIOLOGY IN FINLAND
Meets in Helsingfors.

VIENNA SOCIETY OF ROENTGENOLOGY
Secretary, Professor Holzknecht, Vienna, IX, General Hospital.
Meets on the first Tuesday of each month from October to July.

VIENNA LETTER

(From our special correspondent)

THE COMBINED TREATMENT OF CANCER WITH INJECTIONS OF SUGAR AND THE APPLICATION OF HARD RAYS

At a recent meeting of the Vienna Roentgen Society Professor Dr. Guido Holzknecht gave account of his experiments regarding the preliminary treatment of cancer with the administration of sugar injections and subsequent application of hard rays. He stated that the impulse to these experiments was given by the achievements of Dr. Warburg, the Berlin chemist, who found that animal cancers are nourished by the grape sugar content of the blood. Later on Rona and Deutsch demonstrated that similar proceedings take place in human beings suffering from cancer. The knowledge of this fact has brought us nearer to the possibility of destroying cancer, because, knowing that blood sugar is an indispensable factor in the growth of cancer, we are in the position to check its further development simply by depriving it of its nourishment. This would be very easy if the sugar content of the blood were not needed by some very important organs. This assumption encouraged Silberstein to administer insulin in a liberal manner, for diminishing the blood sugar. His assumption was based on the fact that cancer is able to attract a sufficient amount even from sugar-free blood. Entirely contrary to this were the experiences of E. G. Mayer who tried to super-saccharinize the blood by conveying sugar in the form of injections, and found that by doing so he induced an extraordinarily great change in the cancer itself, because in his cases so treated the sudden super-metabolism going on within the cancer imparted a very marked decrease of resistance against the roentgen rays and radium. He continued his experiments on a considerable number of patients, and these, almost without

exception, bore witness to the correctness of his observations and to the feasibility of his experiments. The number of cases, however, in which this method of treatment proved efficacious, is still not sufficient to warrant a categorical statement as to the practical value of the method. So much is certain that in most cases subjected to this method of treatment, in the laboratory of Professor Holzknecht, the benefit derived from the treatment was not at all to be disregarded. Other Vienna roentgenologists carried on parallel experiments with preliminary sugar injections and subsequent irradiation, and treatment with hard roentgen rays alone, the result being that the animal cancers irradiated after a preliminary application of sugar injections, not only diminished in size more markedly than those simply irradiated, but the animals secreted also more lactic acid-containing waste—the product of decomposing cancer—a proof that the development-metabolism of cancer was harmfully interfered with. Similar reports were recently published also by Dr. Frik, of Berlin.

CHOLECYSTOGRAPHY WITH A SILVER SALT

At the recent meeting of the Medical Society at Oradea Dr. Louis Winkler spoke on the by-effects of tetraiodophenolphthalein. He said that although the nauseating effect of this drug is only temporary, yet he has had several cases in which more severe manifestations were present. In one case the patient had fainting fits associated with convulsions lasting for hours; in another instance, a very serious dyspepsia, lasting for over a fortnight, and loss of appetite lasting for six weeks tormented the patient. In fact, there are scarcely any cases, continued Winkler, in which the administration of tetraiodophenolphthalein is not followed by one or two unpleasant by-symptoms. Induced by these facts, he followed the example of Stewart and Einhorn and applied the drug intraduodenally. He found that by the administration of the drug in this way, its efficacy is curtailed. He then began to give it per rectum, as advised by Professor Stegemann. The latter methods, however, have the disadvantage of being less reliable, and of not being entirely exempt from inconvenient by-effects.

It is not to be wondered at, therefore, that a whole group of experimenters tried to find a contrast drug, which would on the one hand, be free from any adverse concomitant symptoms, and on the other hand afford the possibility of intravenous administration the same as the tetraiodo salt. Dr. Lajos Winkler, senior physician at the polyclinic at Oradea, hit on the idea, in 1925, of administering a well-known silver salt, choleval, which drug, while being apt to give a clear shadow of the gall-bladder on a roentgenogram, is a salt containing a high percentage of silver, and therefore is opaque to the roentgen rays. It is also a very harmless preparation, its evacuation being particularly easy. Its shadow-giving property is further enhanced by the fact that choleval being a cholic acid silver salt, is secreted into the gall-bladder. The intravenous administration of a larger dose is contraindicated by the possibility of the occurrence of a colloidal shock, and because of this he administered it only orally. He dissolved 2–3 grams of choleval in a glass of milk, and after the customary preparation of the patient had him drink the solution. The films have shown the outlines of the gall-bladder distinctly, and allowed an exact diagnosis to be made. Winkler admits that the roentgenograms do not approach in clearness those made after the administration of tetraiodophenolphthalein. He tried to improve the sharpness of the image by increasing the dose of choleval but without success. This he attributes to the fact that the absorption of silver is very slow and consequently its concentration in the gall-bladder cannot be increased beyond a certain degree. On the other hand, the application of choleval is wholly without danger and is devoid of any inconvenient by-effect if employed in the above doses. Winkler is continuing his experiments with another silver preparation and hopes soon to be able to produce clear pictures, not less rich in contrasts than those made with the use of the iodine preparation.

EXPERIENCES WITH ROENTGEN TREATMENT IN OPHTHALMOLOGY

Dr. Adalbert Béla has given an account in the Vienna Roentgen Society of his experiments, carried on for two and a half years in Budapest. Altogether he performed 288 irradiations on 168 patients. The dose generally administered was $\frac{1}{3}$, $\frac{1}{5}$, and $\frac{1}{10}$ of a skin erythema dose. He emphasized that he did not observe any roentgen-ray damage in a single case. The eye diseases for which patients have been irradiated were very different; in cases of conjuncitivitis, regarded as tuberculosis with the formation of tubercles, the effect of irradiation was most noticeable in regard to the subjective symptoms and corneal affection. As to trachoma, pannus and corneal ulcer they receded very quickly. In cases of postoperative hemorrhages the visual power improved within a few days to $\frac{5}{15}$. In cases of chorio-retinitis the visual power improved essentially. In scleritis the relapse was striking by its absence for an unusually long time. In cases of fistulous and phlegmonous dacryocystitis and lymphatic kerato-conjunctivitis the result was varying. In 10 cases of parenchymatous ketatitis the clearing up was quicker, and in incipient cases the infiltration had disappeared. He irradiated 62 patients suffering from iritis and the effect was most striking in the acute cases. In chronic cases multiple irradiations seem to be necessary. He applied local treatment also. In one case of relapsing uveal-body hemorrhage he observed rapid improvement.

ITINERARIES TO INTERNATIONAL CONGRESS OF RADIOLOGY AND EUROPEAN CLINICS

The following itineraries have been furnished to the American Committee by Thos. Cook & Son, 585 Fifth Avenue, New York City.

Tentative rates subject to confirmation two or three months before sailing are quoted in the following letter to Dr. Jaches who is attending to matters of transportation for the American Committee:

Dr. Leopold Jaches,
27 East 95th St.,
New York City.
Dear Sir:

The rates for the enclosed itinerary will be as follows:*

Tour No. 1—$632.00 each of 15 persons if Ordinary 1st hotels and $794.00 if Superior 1st Hotels.

Tour No. 2—$620.00 each of 15 persons if Ordinary 1st hotels and $784.00 if Superior 1st hotels.

Tour No. 3—$151.00 each of 15 persons if Ordinary 1st hotels and $177.00 if Superior 1st hotels.

Tour No. 4—$137.00 each of 15 persons if Ordinary 1st hotels and $158.00 if Superior 1st hotels.

These rates will provide for the following services:

Rail and steamer transportation tickets in accordance with the itinerary.* The class to be second on the Continent, third in Great Britain and saloon on local steamers with ordinary first class hotels and first class throughout with superior first hotels.

Note. Rooms with private bath will be provided whilst in Paris at Superior first hotels. Accommodations will consist of double rooms without bath and all meals.

Transfers of passengers and hand-baggage between hotels and railway stations where necessary.

Sightseeing excursions as specified in the itinerary.

Meals en route whilst sightseeing and riding on trains.

You will note that the rates are based on a party of 15 persons and a new quotation must be obtained for a smaller party.

Yours very truly,
Thos. Cook & Son.

With regard to the choice of intineraries the following paragraph from a letter from Dr. Jaches to the secretary of the American Committee is pertinent:

"As you will probably have noticed reading the letters of the German radiologists which were sent to me, they would prefer a visit from the Americans before the Congress rather than after. Judging from previ-

*The rates do not include trans-Atlantic passage to and from Europe. These vary for the round trip between $300 and $700 per person according to accommodations.

ous experience I would advise the Americans who want to visit the Continental European clinics to do so before the Congress. The period following it, namely August, is generally vacation time in the various institutes and universities, while these institutes are operating to full capacity up to about the end of July. The length of stay at any particular place may, of course, be modified either before the trip is started or while in Europe."

TOUR NO. 1

May 30th Sail from New York by Cunard Line Cabin steamer "Lancastria."
June 8th Arrive Havre and rail to Paris.
June 9th *In Paris.* Private automobile bus and guide will be at the passengers' disposal for two days' sightseeing as follows.
to 1st day Visiting the city including the Louvre, Cathedral of Notre Dame, Eiffel Tower, Napoleon's Tomb, Tomb of the Unknown Soldier, etc.
June 21st 2nd day To Versailles and the Chateau of Malmaison.
June 22nd Day train via Metz to Frankfurt.
June 23rd *In Frankfurt.* Private automobile and guide
to will be at the passengers' disposal for one
June 27th day's sightseeing about the city.
June 28th Rail to Nuremberg.
June 29th To Vienna.
June 30th *In Vienna.* Private automobile bus and
to guide will be provided for one day's drive
July 4th around the city visiting the many points of
July 5th interest.
July 6th Rail to Prague.
July 7th To Berlin.
July 7th *In Berlin.* Private automobile bus and
to guide provided for half day's drive in the
July 11th city and one day to Potsdam and return.
July 12th To Hamburg on morning train.
July 13th *In Hamburg.* Private automobile and guide
to will be at the passengers' disposal for one
July 17th day's sightseeing around the city.
July 18th Day train to Copenhagen.
July 19th *In Copenhagen.* Private automobile bus
to and guide for one day's sightseeing about
July 20th the city. Leave on night train for Stock-
July 21st holm. (Sleeping car berth included.)
July 22nd Arrive Stockholm A.M.
In Stockholm. Private auto bus and guide
to will be at the passengers' disposal for one
July 28th day's sightseeing about the city also
July 29th excursion on one day by auto to Upsala
July 30th and return.
July 31st Leave by steamer via Gota Canal for Gothemburg.
Aug. 1st En route on Canal Steamer.
Aug. 2nd Arrive Gothenburg.
Aug. 3rd Embark on Swedish Lloyd Steamer for
Aug. 4th Tilbury.
At sea.
Arrive Tilbury and rail to London.
In London. Private automobile bus and guide will be at passengers' disposal for two days' visiting the following points of interest.
to 1st day Excursion around the city including London Museum, Tower of London, St. Paul's Cathedral, The Guildhall, Mansion House, Buckingham Palace, etc.
2nd day To Windsor Castle, Eton College and Stoke Poges.
Aug. 10th
Aug. 11th Rail to Southampton and sail by Cunard Line cabin steamer.

TOUR NO. 2

July 5th Sail from New York by Swedish American Line Steamer about this date.
July 14th Arrive Gothenburg.
July 15th *In Gothenburg.* Private auto and guide will
to be provided for one day's sightseeing about
July 16th the city.
July 17th Leave by Gota Canal steamer for Stockholm.
July 18th En route on Gota Canal.
July 19th Arrive Stockholm in the evening.
July 20th *In Stockholm.* Private automobile bus and guide will be at the passengers' disposal for one day's sightseeing about the city
to also excursion on one day by auto to Upsala and return. Leave on night train for Copenhagen. (Sleeping car berth
July 28th included.)
July 29th *In Copenhagen.* Private automobile bus
to and guide provided for one day's sight-
July 30th seeing about the city.
July 31st Day train to Hamburg.
Aug. 1st *In Hamburg.* Private automobile bus and
to guide provided for one day's sightseeing
Aug. 5th around the city.
Aug. 6th Morning train to Berlin.
Aug. 7th *In Berlin.* Private automobile bus and guide
to provided for half day's drive in the city,
Aug. 11th also one day to Potsdam and return.
Aug. 12th Rail to Prague.
Aug. 13th To Vienna.
Aug. 14th *In Vienna.* Private auto bus and guide will
to be at the passengers' disposal for one day's
Aug. 18th sightseeing to points of interest about the city.
Aug. 19th Rail to Nuremberg.
Aug. 20th To Frankfurt.
Aug. 21st *In Frankfurt.* Private auto and guide will
to be at passengers' disposal for one day's
Aug. 25th sightseeing about the city.
Aug. 26th Day express via Metz to Paris.
Aug. 27th *In Paris.* Private auto bus and guide will be at the passengers' disposal for two days' sightseeing as follows:
1st day In the city visiting the Louvre,
to Cathedral of Notre Dame, Eiffel Tower, Napoleon's Tomb, Tomb of the Unknown Soldier, etc.
2nd day To Versailles and the Chateau
Sept. 7th of Malmaison.
Sept. 8th Via Calais and Dover to London.
Sept. 9th *In London.* Private auto bus and guide will be at the passengers' disposal for two days' sightseeing as follows:
1st day In the city visiting London
to Museum, Tower of London, St. Paul's Cathedral, Buckingham Palace, etc.
2nd day To Windsor Castle, Eton College, Stoke Poges.
Sept. 15th
Sept. 16th Rail to Southampton and sail for New York by Cunard Line cabin steamer.

TOUR NO. 3

July	5th	Sail from New York by Swedish American Line steamer about this date.
July	14th	Arrive Gothenburg.
July to July	15th 16th	*In Gothenburg.* Private auto and guide will be at the passengers' disposal for one day's sightseeing about the city.
July	17th	Leave by Gota Canal steamer for Stockholm.
July	18th	En route on Gota Canal.
July	19th	Arrive Stockholm in the evening.
July to July	20th 28th	*In Stockholm.* Private automobile bus and guide will be at the passengers' disposal for one day's sightseeing about the city also excursion on one day by auto to Upsala and return. Leave on night train for Copenhagen. (Sleeping car berth included.)
July	29th	Rail to Gothenburg.
July	30th	Sail for New York about this date by Swedish American steamer.

TOUR NO. 4

July	7th	Sail from New York per S. S. "Republic" of the U. S. Lines.
July	19th	Arrive Bremen.
July	20th	Leave on morning train via Malmo. (Sleeping car berth included.)
July	21st	Arrive Stockholm A.M.
July to July	22nd 28th	*In Stockholm.* Private auto and guide will be at passengers' disposal for one day's drive about the city, also excursion on one day to Upsala and return.
July	29th	Rail to Gothenburg.
July	30th	Sail for New York about this date by Swedish American Steamer.

(1928 *Sailings not yet published.*)

PHILADELPHIA CLINICAL MEETING FOR RADIOLOGISTS

Following a meeting last February, sponsored by the New York Roentgen Society, a committee consisting of Drs. David R. Bowen, Arthur C. Christie, George W. Holmes, Leopold Jaches and Chas. A. Waters was formed to plan a meeting for 1928. This Committee has accepted an invitation unanimously tendered by the Philadelphia Roentgen Ray Society for the date (tentative) January 27–28, 1928.

The sessions, with the possible exception of Friday evening, will be wholly clinical. Most sessions will be given in the large amphitheaters accommodating the entire attendance, but it seems that a part will necessarily be given to smaller groups and upon the ticket plan. In any case, great pains will be taken to so arrange and plan that no guest will "get lost" or needlessly waste time.

Programs will be mailed by January 1, to all members of local roentgen ray societies in the Atlantic states and to all who answer this notice.

The length of the program will be as short as is consistent with the amount of material submitted. If any considerable number indicate a desire to spend the remainder of the week end in Atlantic City, the program will end in time for them to take the 4 P. M. train on Saturday.

For programs, address Dr. David R. Bowen, Pennsylvania Hospital, 8th and Spruce Sts., Philadelphia, Penna.

Requests or suggestions concerning items desired in the program should be sent to the Chairman of the Philadelphia Committee, Dr. Eugene Pendergrass, 3400 Spruce St., Philadelphia, Penna.

DR. CHILDS HONORED BY STATE SOCIETY

It will be interesting to the readers of the Journal to learn that Dr. Samuel B. Childs of Denver, Colorado, a long time member of the American Roentgen Ray Society and one of our pioneer roentgenologists, was elected president of the Medical Society of the State of Colorado at its meeting held in Glenwood Springs, Colorado, on September 9, 1927.

Subscribers to THE AMERICAN JOURNAL OF ROENTGENOLOGY & RADIUM THERAPY *visiting New York City are invited to make the office of the publishers (Paul B. Hoeber, Inc., 76 Fifth Avenue, New York) their headquarters. Mail, packages or bundles may be addressed in our care. Hotel reservations will gladly be made for those advising us in advance; kindly notify us in detail as to requirements and prices. List of operations in New York hospitals on file in our office daily.*

Vol. XVIII, No. 4

DEPARTMENT OF TECHNIQUE

Department Editor: DAVID R. BOWEN, M.D., Pennsylvania Hospital, Philadelphia, Pa

In this department will be published from time to time, as material is available, suggestions for improvement in technique.

A METHOD OF PRECISION IN STEREOSCOPIC ROENTGENOGRAPHY

BY HENRY F. KURTZ,* AND EZRA BRIDGE, M.D.†

ROCHESTER, NEW YORK

INTRODUCTION

OUR interest in stereoscopic roentgenography was precipitated by dissatisfaction with the diagnostic aid derived from stereoroentgenograms, caused by the disproportionate lack of thickness of a chest, the apparent dislocation of pathological conditions and other similar phenomena. The problem is attacked from the premise that the ideal view of a subject would be that gained by observing a translucent model of it with the unaided eyes. This premise naturally leads to a consideration of unaided binocular vision. Helmholtz[1] and others[2] have shown that stereoscopic vision gives rise to plasticity because of differences in the views presented to the two eyes dependent upon interpupillary separation. Helmholtz's investigations led him to the conclusion that the least discernible difference between these views is that represented by 60 seconds of arc. Later experimenters[3] have proven many times that 10 seconds of arc is more nearly a correct value for normally acute vision. Assuming 65 mm. as the normal interpupillary separation and taking a mean value of 30 seconds as the limiting angle, we reach the conclusion that stereoscopic vision, or the rendition of plasticity is limited to distances of 447 meters (1467 feet) or less. That is to say, all parts of a view beyond 1467 feet will have no plasticity. Suppose now, that a pair of stereograms is to be observed in such a manner that the object is to be recomposed plastically at a distance of 45 inches. The assumed conditions immediately dictate that each elementary small portion of each picture of the pair must be located with a limiting accuracy of 30 seconds of arc. This angular value interpreted in terms of linear measure at the distance of 45 inches is of the order of $\frac{1}{200}$ inch. Many factors, such as variation in interpupillary distance in different observers, movements of the patient between exposures, internal physiological movements, shrinkage of film in drying, inevitable errors in measurements of distance and location of films in the stereoscope, etc., all militate against the achievement of this degree of accuracy in practical stereoroentgenography. It is perhaps unnecessary for practical purposes to achieve it completely, but certainly this degree of accuracy, and perhaps three times as much, is necessary for the accomplishment of *absolutely precise* results. It is patent that the present unsystematic exposure technique, and inaccurately constructed and carelessly used viewing apparatus leave room for a long stride in the direction of precision.

DISCUSSION

The purposes of this paper are to outline the necessary conditions for accurate and comfortable stereoscopic vision, to show how the usual practice in stereoscopic roentgenography fails to meet these conditions, to set forth an exposing and viewing technique founded upon these principles of vision, to describe the stereoscope devised to permit the exercise of this technique to the greatest possible extent.

The necessary general conditions for accurate and comfortable stereoscopic vision are a harmony between accommodation and convergence and a precise and

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† Medical Director of Iola Sanatorium, Rochester, N. Y.

definite difference *between* the views presented to the two eyes. An appreciation of the importance of these conditions is dependent upon an understanding of what accommodation and convergence are.

Charles H. May[1] says:

"Accommodation is the *power of altering the focus of the eye* so that divergent rays (those coming from an object nearer than 20 feet) are brought together on the retina; this is accomplished by means of an *increase in the convexity of the lens*, and thus in its refractive power. The degree of accommodation *must vary for every distance* of the object; the eye cannot be adapted for two different distances at the same time.

"The preceding considerations of the subject of accommodation refer to monocular vision or sight with one eye. With *binocular vision* it is necessary to consider *convergence* as well as accommodation. For these two actions (together with the contraction of the pupil) are normally associated.

"Convergence is the power of directing the visual lines of the two eyes to a near point, and results from the action of the internal recti. When we look at a distant object accommodation is at rest and the visual lines are parallel. When we look at a near object, we are compelled both to accommodate and to converge for that distance; *with a certain amount of accommodation, a corresponding effort of convergence of the visual line is associated.*"

Illustrative of these definitions of May, consider Figures 1 and 2. Let E and E_1 (Fig. 1) represent the eyes of a person with normal vision viewing an object at O. Under the conditions illustrated in the left diagram the eyes will accommodate for the distances EO, E_1O, and will converge as indicated by the angle EOE_1; under those in the right diagram the eyes will accommodate for the greater distance of the object, and will converge as shown by the smaller angle. It is evident then, that there is only one degree of convergence and a corresponding single degree of accommodation for a given distance. If, by some artificial means, an observer should be forced to view an object under a degree of convergence not in keeping with the accommodation, his eyes would "feel strained" and the object would not appear true in form and possibly not at the proper place in space. Thus, a specific interaction between accommodation and convergence is essential for stereoscopic vision. Authority for these statements and amplification of these principles may be found in any of the texts on physiological and visual optics.

When an object is viewed at a definite distance with both eyes, the picture presented to the left eye differs from that presented to the right eye. It is further true and obvious that views of the same object seen from different distances are different. In other words, the right and left views will differ from each other at any distance, and the pairs of views will vary with the distance. Observation of Figure 2

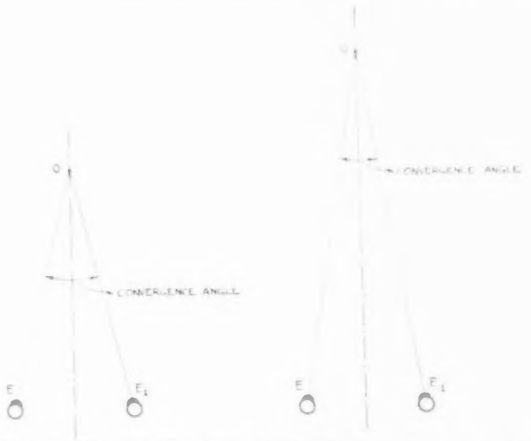

FIG. 1. Illustrating the variation in convergence angle with viewing distance.

will make these differences clear. The object is a cube at a comparatively short viewing distance, the upper left picture showing it as seen by the left eye and the upper right picture as seen by the right eye. The lower left and right pictures show the same aspect of the cube but from a greater viewing distance. Consideration of these pictures will show that at the shorter distance the picture for the left eye differs from that of the right eye; that at the greater distance the pictures for the two eyes also differ from each other. These are the differences that make stereoscopic vision possible. But it will be noted that the pair of views at the greater distance is further different from the pair at the shorter distance. This difference is of particular interest in connection with the

subject of this paper. It is now plain that only one pair of pictures can be produced by binocular vision at a given distance.

The fulfillment of the conditions of harmony between accommodation and convergence and a specific difference between the views presented to the individual eyes is *sufficient* for the production of plastique. In order that the degree of plastique shall not be excessive or insufficient, that is, that the third dimension shall be precise, the fulfillment of a third condition is necessary. This condition is dependent upon the fact that the degree of difference between the right and left pictures increases as the viewing distance decreases. The difference at a given distance is therefore specifically peculiar to that distance. This, interpreted in terms of roentgenologic stereoscopy means that films taken at a given distance must be viewed at the same distance, or under geometrically homologous conditions secured by a properly designed lens viewing system. Violation of this third condition is the root of the failure of the present technique to afford the degree of accurate recomposition of which roentgenologic stereoscopy is capable. Our analysis of the different techniques for exposing and

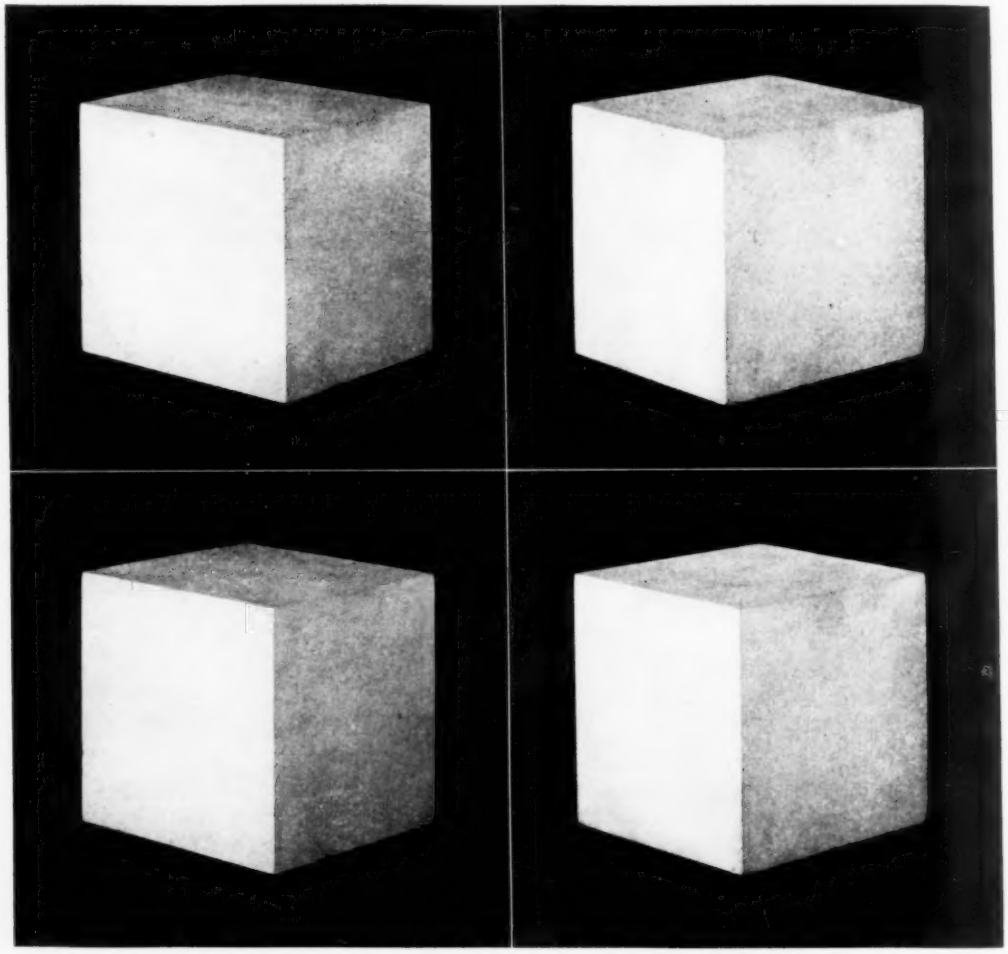

Fig. 2. Illustrating the variation in the views of a cube as seen with the individual eyes and at different viewing distances. The left pictures are the views received by the left eye and the right pictures are those received by the right eye. The upper pair are as seen from a comparatively short viewing distance, the lower from a greater viewing distance. Note the differences in location of the upper rear corner of the cube with respect to the front vertical edge and the differences in angular relation to each other of the edges, due to perspective.

viewing stereoroentgenograms shows that in each of them one or more of these three conditions are violated.

The usual practice in exposing stereoroentgenograms is difficult to define as operators use various techniques. But, in general, the distance of the tube from the film varies from 20 to 60 inches and, with few exceptions, the tube shift is $2\frac{1}{2}$ inches. In this paper stereoscopic roentgenography of the chest is used as an illustration, and it is understood that roentgenograms in the past have been made almost invariably

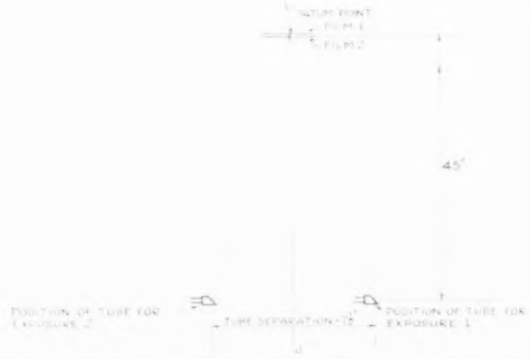

FIG. 3. The exposure arrangement. The plane of the paper contains the middle points of the films and the active point of the tube anode in its successive positions. The films are shown slightly separated, but are actually placed successively in the same position.

with a tube shift of $2\frac{1}{2}$ inches and at an exposure distance varying from 30 to 60 inches. This means that no consideration has been given to convergence angle conditions. What is presented regarding chest roentgenograms is applicable to those made of other parts of the body.

As a rule chest roentgenograms have up to the present time been viewed in a stereoscope having a viewing distance of 27 to 36 inches. The practice of viewing films exposed at distances of from 20 to 60 inches in an apparatus with a viewing distance varying from 27 to 36 inches is a violation of the principles of accurate stereoscopic vision already summarized. Due to this violation it is common experience for an observer to receive an impression that the chest lacks depth to a marked degree, and to experience discomfort. It is therefore obvious that the common practice of taking stereoroentgenograms without due regard for these principles and the practice of placing them in a stereoscope in the accepted haphazard fashion, tilting the viewing mirrors in all directions until a semblance of fusion is secured, will not produce satisfactory results.

The first step in the establishment of a correct exposing and viewing technique and in the development of an appropriate stereoscope is the determination of the normal viewing distance. This is a fundamental factor representing a constant about which the whole system of exposure

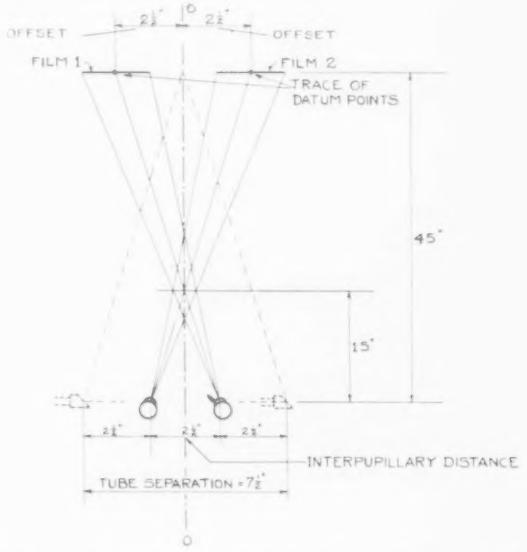

FIG. 4. Illustrating a step in the evolution of the stereoscope. In this system accommodation and convergence do *not* harmonize.

and observation is built. It may be defined as that distance between the eyes and an object that results in maximum plasticity consistent with comfort. The nearer, within reasonable limits, an object is to the eyes, the more pronounced is the plasticity, that is, the impression of form or of third dimension becomes more pronounced as the distance diminishes. Experience shows that an object may be comfortably viewed at a distance of 15 inches but that as the distance becomes less, vision becomes difficult because of the severe accommodative effort. The average person with active accommodation sees comfortably at 10 inches, but allowing for variation in individuals, it is reasonable to assume 15 inches as

the normal viewing distance. Since the selection of this optimum can only be the result of personal judgment, our choice of 15 inches may be debatable. Any other distance justified by judgment may be used with the reservation that the design of the apparatus and the exposing and viewing technique be kept in accord with the principles under discussion.

When the normal viewing distance is settled upon, the convergence angle is automatically established as the second step in the process, since it must be the

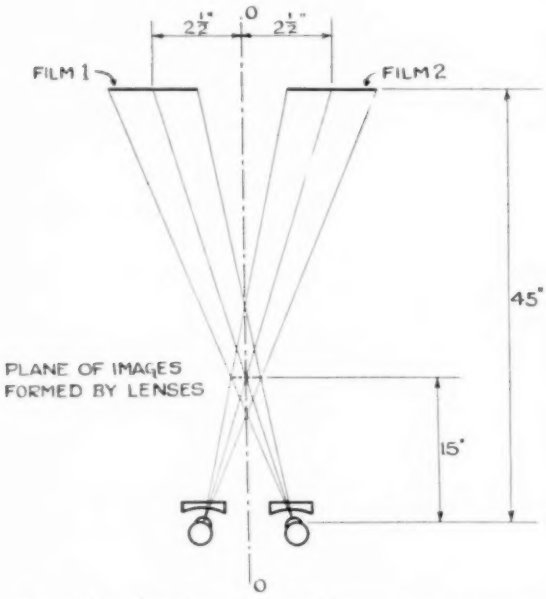

Fig. 5. Showing the addition of lenses to the arrangement in Figure 4, to harmonize accommodation with convergence.

subtense of the interpupillary distance, namely, 2½ inches, at the viewing distance, assumed here to be 15 inches. Theoretically, this means that in taking stereoroentgenograms the plane of the anode of the Coolidge tube should be 15 inches away from the film and that the tube separation should be 2½ inches. As it is manifestly impossible to work at this distance, other expedients must be resorted to in order to obtain correct convergence conditions. It was found upon experiment that a distance of 45 inches of the anode from the film is suitable. At this distance the entire chest of the larger subjects is projected upon a 14″ × 17″ film when exposed with the necessary tube shift. At smaller distances this is not true. In order to meet the required convergence condition for this distance the shift must be -1½ inches. The triangle represented by the subtense of -1½ inches at 45 inches is mathematically proportional to the triangle represented by the subtense of 2½ inches at 15 inches.

The third step is the establishment of means whereby the films may be located in the stereoscope accurately. In other words, a pair of films taken under the assumed specific conditions of convergence and exposure distance must be located in the stereoscope in only one position with respect to the optical axes of the stereoscope and of the exposure apparatus in order that they may be viewed under these specific convergence conditions. To this end a pair of small points, opaque to roentgen rays, may be placed on the door of the film changing apparatus. A pair of fiducial marks may be placed in similar positions on each of the illuminated surfaces of the viewing boxes. When the films are placed in the stereoscope the traces of the points may be made to coincide with the fiducial marks, thereby assuring proper position and orientation of the films. This precision of location is one of the necessary steps in the technique.

The fourth step is the precise location of the reflectors of the stereoscope both in respect to position and rotation. A pair of 90° reflecting prisms or plane mirrors may be used. An advantage of the prisms or of first surface mirrors is the total absence of disturbing secondary reflections. The method of locating these reflectors is brought out in the description of the stereoscope.

In the design of the stereoscope it is necessary to adhere to these four conditions, summarized as foliows: (1) vision at the normal viewing distance, giving maximum plasticity; (2) the use of a convergence angle in keeping with this distance; (3) accuracy of location of the films with the assistance of datum traces and fiducial marks, and (4) a fixed and correctly located and oriented reflector system.

A schematic diagram of the exposure arrangement is shown in Figure 3. The two

positions of the light source and the geometrical center of the film define a plane which is perpendicular to the film. An imaginary axial line O O lies in this plane. It contains the geometrical center of the film and bisects the line joining the two exposure positions of the light source. While film 1 and film 2 are shown slightly separated in the diagram, they are actually placed successively in the same plane. Since the exposure distance is 45 inches and

same positions occupied during exposure, and if the right eye be placed in the position of the light source for exposure 1, and if the left eye could be placed at the position of the light source for exposure 2, a precise and comfortable view of the object exposed would be received, providing the right eye could view only exposure 1 and the left eye only exposure 2. This is impossible because a $-1\frac{1}{2}$ inch interpupillary distance does not exist and because

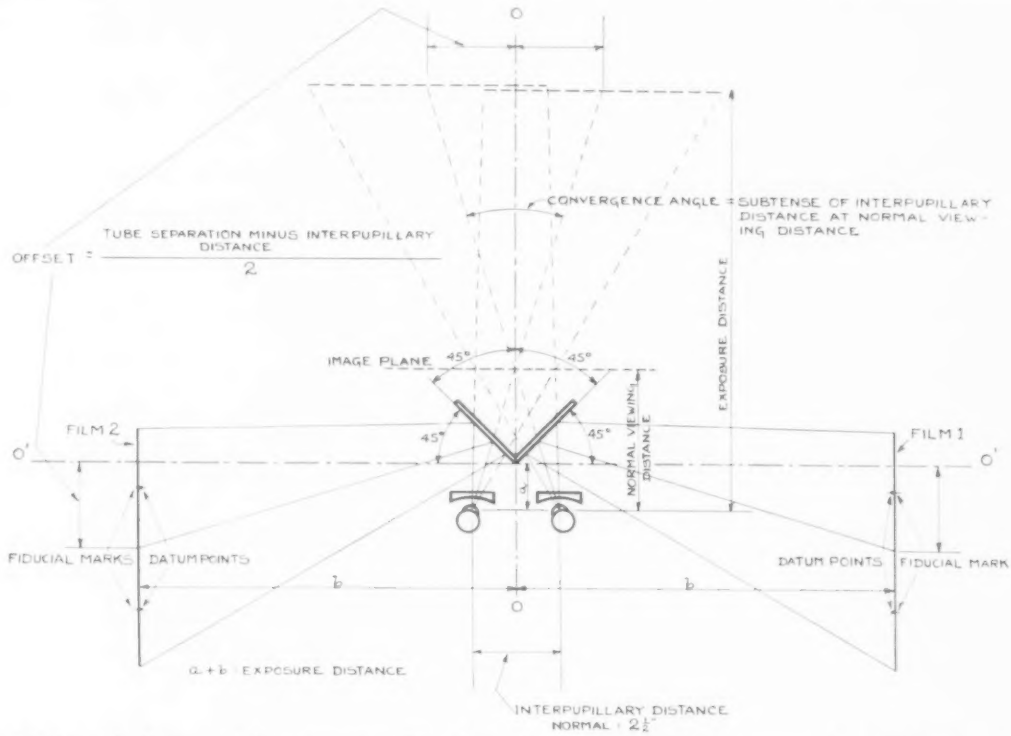

FIG. 6. Schematic diagram of the stereoscope. The plane of the paper contains the axes of the viewing system. The films and reflectors must be perpendicular to this plane. The mirrors must be at 45° to the axes, and the films normal to them. All distances must be held rigidly to those specified in the diagram to attain precision.

we have chosen 15 inches for the normal viewing distance the tube separation will be $-7\frac{1}{2}$ inches giving a convergence angle which is the same as that subtended by $2\frac{1}{2}$ inches at 15 inches. For convenience, the datum point is indicated on the axis. In practice the datum system should consist of at least two points at any suitable places on the film with the reservation that the fiducial marks on the viewing boxes be correspondingly located.

If the films after development were replaced in this system in precisely the

the arrangement will not permit selectivity for the individual eyes.

The next diagram (Fig. 4) shows an expedient designed to overcome these two difficulties. The right film (No. 1) is offset to the left $2\frac{1}{2}$ inches and the left film (No. 2) is offset to the right $2\frac{1}{2}$ inches. These movements allow vision under the correct convergence with an interpupillary distance of $2\frac{1}{2}$ inches. It is essential that these movements be understood to be pure translation, with no rotation, either of exposure or lines of sight. It is further

assumed, for clarity, that the films are very small, so that this amount of translation will completely separate them. It will be observed that the axes of vision now intersect at the assumed normal viewing distance of 15 inches. This expedient therefore fulfills the convergence condition. But the condition of harmony with accommodation with convergence is not fulfilled. The eyes are attempting to accommodate for 45 inches and at the same time to converge for 15 inches.

The diagram (Fig. 5) shows a system in every way identical with that of Figure 4 excepting that a negative lens is placed before each eye. These lenses are so chosen that they image the films at the intersection of the lines of sight, 15 inches from the eyes. They will be comparatively weak ($2\frac{1}{2}$ dioptres). Since they are placed close to the nodal points of the eyes, the angles subtended by the images, formed by these lenses will be equal, within the limits of negligible variation, to those subtended by the films when viewed without lenses. The addition of these lenses harmonizes convergence and accommodation. The ultimate result is that the observer receives a view of the object which is characterized by unit angular magnification and complete comfort. This arrangement constitutes a correct stereoscope for pictures small enough to be entirely separated by the offset introduced.

As the films will often be 14″ × 17″, the offset used in Figure 4 will be insufficient to separate them entirely and recourse must be taken to the reflection type of stereoscope. The diagram (Fig. 6) shows the addition of reflectors to the system of Figure 5 together with the resultant geometry. The reflectors are placed in such a manner that each lies at an angle of 45 degrees to the axis O O, that each is perpendicular to the plane defined by the two positions of the light source and the center of the film (as shown in Fig. 4) and so that this plane pierces them at mid-height. The axis O O is imaged normally to itself and extends to the right and left (line O′ O′). The centers of the films are so displaced with respect to these imaged axes that their distance from the imaged axes is equal to $\frac{1}{2}$ the tube shift minus $\frac{1}{2}$ the interpupillary distance. The fiducial marks must be located so that their height above the plane defined by the exposure positions of the light source and the center of the film is equal to the height of the datum points above this plane. In practice any conveniently located pair of points will serve. The air distance, or optical path length from the eye to the reflecting surface, thence to the film must be equal to the exposure distance. If prisms are used for reflectors, the glass path of the prisms must be reduced to air path in adjusting the air distance. When these conditions are met the pictures will "snap" into fusion instantly and a restful view will result in which all distances and proportions will be accurate. It will be characterized by the plasticity resultant upon vision at 15 inches and the object will have angular size incident upon viewing it at the exposure distance with unaided eyes. If any of the above conditions is violated fusion will be difficult and recomposition inaccurate.

When a stereoscope constructed along these lines is used, the first impression is that the resultant image is smaller than that seen with the usual stereoscope having a viewing distance of 25 to 36 inches. This is because the stereoscope described here affords a view equal to that of the object placed 45 inches from the observer, while the usual stereoscope affords a view equal to that of the object placed only 25 to 36 inches from the observer. This apparent reduction in size instead of being a disadvantage, actually redounds to the advantage of the observer because of lessened "fuzziness" and an enhanced crispness of detail. Roentgenograms are shadowgraphs and, at best, lack what the photographer or optician calls definition. The greater viewing distance tends to lessen the effect of this lack of definition. After a little practice the observer becomes accustomed to this smaller image and sees in it a decided advantage.

The question naturally arises: Why cannot pictures taken at 45 inches with a $7\frac{1}{2}$ inch tube shift be satisfactorily viewed when placed in a stereoscope with, say, a 25 inch viewing distance, providing proper allowance is made for offset to give proper

convergence, and if lenses are selected to give harmonizing accommodation? This question has been investigated experimentally and the results verified by projective geometry. It was found that such practice results in insufficient plastique, or in other words, inaccurate third dimension. The production of third dimensional views is the sole reason for the practice of stereoscopy and its accurate production is the problem discussed in this paper. Proof of the fact that errors of plasticity are introduced by viewing stereograms under conditions different from those described as being correct, requires the application of rather involved principles of projective and perspective geometry. It is of sufficient importance and interest to comprise the subject matter of a complete discussion and is therefore too involved for introduction here.

Views taken at any exposure distance may be viewed in accordance with the principles laid down providing that (1) the optical path length from the eye to the film is equal to the exposure distance; (2) the tube separation is held to that required for the maintenance of the convergence angle established by the selected normal viewing distance; (3) the offset is kept equal to $\frac{1}{2}$ the tube separation minus the $\frac{1}{2}$ interpupillary distance, and (4) providing lenses are used which image the films at the selected normal viewing distance. It is practicable to build an instrument adaptable to all of these conditions, if the viewing boxes are made movable along the imaged axes with scales and the fiducial marks (or reflector system preferably) are made movable perpendicularly to these axes with corresponding scales. These scales may be calibrated and numbered in terms of exposure distance, if the normal viewing distance is held constant for the instrument. If a varying normal viewing distance condition is desired a series of scales calibrated accordingly will be required. The lenses may be made easily interchangeable and may be suitably engraved.

CONCLUSIONS

The significant points touched upon in this discussion are:

1. Stereoroentgenograms should be taken and viewed under conditions that permit the harmonious relation of accommodation and convergence enjoyed in unaided vision.

2. They should be made and viewed under conditions permitting the optimum plasticity. In our experience and opinion these conditions are satisfied by using a 15 inch normal viewing distance as a basis upon which to build an exposure technique and viewing apparatus.

3. Negative lenses in such a system promote crisp definition and permit the rendition of detail lost when such lenses are not used.

4. The stereoscope should be rigidly and fixedly built and should provide for the introduction of films in the correct position as accurately as is practicably possible.

5. Stereograms made and viewed under these conditions permit comfortable observation and accurate localization of pathological conditions to a degree not previously experienced.

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LOCALIZATION OF FOREIGN BODIES IN THE EYE

AN ADDITIONAL SAFEGUARD

BY GORDON E. RICHARDS, M.B.

TORONTO, CANADA

A RECENT article by Stephenson in the November, 1926, number of the American Journal of Roentgenology and Radium Therapy calls attention to a possible error in the localization of foreign bodies in certain positions of the eye, and opens up a very interesting point as to the possibility of proving in any given case whether a foreign body is within or outside the eyeball. The method which this author describes was fully given by Van Zwaluwenburg in the American Journal of Roentgenology, October, 1917, and in that author's summing up of his excellent article he touched the crux of the matter in these words:

"This (method), of course, presumes that the diagram correctly represents the size and shape of the eye"—i.e., under examination.

In view of the fact that the human eye may vary from 22.5 mm. to 26 mm. within the limits of an emmetropic eye, it is of course obvious that in an occasional case one is bound to be in error if we must assume that the particular eye in question is of average length, which as Van Zwaluwenburg points out is 24 mm.

And while the method detailed by Stephenson in his article, as in the earlier article mentioned, is a very valuable one which should undoubtedly be used as a check, yet it is subject to this fundamental objection, namely, that one must assume that the eye is of average length.

FIG. 1. Single film showing foreign body in region of orbit, localized 24 mm. back of the cornea.

FIG. 2. Same case as Figure 1. 1 shows position of foreign body when the eye is rotated upward, and II the position when it is rotated downward.

For many years I have made use of a simple procedure as an additional check on all localizations in which a foreign body is shown in any of the positions suggested by Stephenson—or in fact in any case in which the foreign body seems likely to be in or near the sclera, and in which it is important to determine whether it is

within the eye, in the wall of the eye, or outside the eyeball altogether.

This method we have called the "parallax" method, and while we do not claim that the method is original with us, I have not succeeded in finding a description of it in the literature and have been somewhat surprised at this since it is a simple obvious procedure which seems to offer the only possible means of proving the point at issue, regardless of measurements of the eye.

To carry out the procedure properly requires some coöperation on the part of the patient, and usually requires that the eye be not too badly damaged. Since, however, it is more important to preserve the undamaged eye than one which has been badly injured, it will be found of chief importance in exactly this group of cases.

THE PARALLAX METHOD

The patient lies on the side, the injured eye next the cassette. The roentgen tube is centered directly over the eye and the patient is then asked to look at an object as far as he can see in the cephalic direction, i.e., the eye is rotated upwards as far as possible. In this position of the eye the first exposure is made. Then without moving tube, patient or cassette, the patient is instructed to look down (in the caudal direction) as far as the eye can be rotated, and the second exposure is made on the same film as the first. If the foreign body is within the eyeball, the rotation of the latter between the two exposures will obviously show the foreign body in two positions. If it is outside the eyeball it will not move, and will show in a single position only.

Of course there are possible positions of a foreign body within the eye in which no movement would be shown, but these would at once be indicated by the Sweet method, and are not the cases in which the present problem is likely to arise.

The case presented herewith illustrates the procedure perfectly. The Sweet chart localized the foreign body 24 mm. back of the cornea, and according to the chart it should have been embedded in the posterior wall of the eye. Yet a difference in the measurement of the eye of 2 mm. (or even less) would place the foreign body outside the globus altogether, and the responsibility for this decision is placed upon the roentgenologist. As the films show very clearly the foreign body moved a considerable distance with the rotation of the eye, and we are able to say quite positively that the foreign body is inside—not outside—that particular eye, regardless of measurements. The Sweet chart then gives the oculist the exact location.

The method has been found valuable in numerous foreign bodies in different positions around the sclera, and I believe is a useful addition to the standard procedures in use. It is not necessary to point out that the patient's head must not move during the carrying out of this procedure. Fortunately any such movement will cause a blurring of the lines of the skull in the two exposures, and any plate in which the various bony lines do not check perfectly, or show any movement whatever, should at once be discarded.

INTERNATIONAL ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

Åkerlund, Ake, Ohnell, Harold, and Key, E. Diaphragmatic hernia through the esophageal hiatus. *Acta radiol.*, 1926, vi, 1–68.

Roentgenological. Diaphragmatic hernia through the esophageal hiatus may properly be termed "hiatus hernia." Such hernias are often true and non-traumatic and may be classified into three groups: (1) those associated with congenitally shortened esophagus (thoracic stomach); (2) periesophageal hiatus hernias, and (3) those not included in the above two groups. A survey of the literature comprising 60 cases besides the authors' own collection of 24 cases shows that hiatus hernia—contrary to prevailing opinion—must be considered a relatively common affection. Anatomically, but not roentgenologically, one can distinguish the real hiatus hernia from the rare "circumscribed eventration of the diaphragm" (diaphragmatic diverticulum around the hiatus).

In all the authors' cases the hernia contained a greater or lesser portion of the stomach and the abdominal esophagus. The hernial pocket is situated in the posterior mediastinum and can project more or less into either pleural cavity. Hiatus hernia is most often and easily demonstrated roentgenologically with the patient in supine or prone position, or lying on the right side with pelvis elevated. Sometimes it may be necessary to apply manual compression to the epigastrium. Roentgenologically the hernia appears as a larger or smaller (often quite small) epidiaphragmatic recess having the shape of a ball, egg, bulb or loop projecting from the shadow of the stomach and usually having a broad communication with it. From the standpoint of differential diagnosis special mention must be made of diverticula from the fornix ventriculi, diverticula from the distal end of the esophagus and insufficiency of the cardia with filling of the abdominal esophagus ("epicardia").

The roentgenological findings in the present series of cases of hiatus hernia in which the hernial contents according to the roentgenogram consisted only of a larger or smaller portion of the stomach together with the abdominal end of the esophagus, were found to be very uniform in shape. There was a certain degree of variation in the roentgen pictures due to the difference in size and position of the herniated portion of the stomach in the individual cases. The only classification of the findings that seems to be feasible is rather crude and the groupings are not sharply distinguishable. However, for practical purposes one may distinguish (1) the large hernias in which the whole stomach or a major part of it is herniated; (2) the medium sized type in which a limited portion of the stomach, of the size of a plum or greater, is included in the hernia, and (3) the small type containing in the sac a portion of the stomach smaller in size than a plum. The large hernias are not limited within the bounds of the posterior mediastinum but were found to spread out far into the pleural cavities or over the lung fields either on the left side or more frequently on the right. The medium sized hernias were found generally to lie in the median position behind the heart in the posterior mediastinum. Their dimensions were found to vary somewhat between that of a plum and a doubled fist. The small hernias were often found to be no larger than a walnut and of even smaller size. Five such cases were encountered in the present series. Such small hiatus hernias appear not to have been reported in the literature heretofore. In none of the cases in this series was there roentgenological evidence of congenitally shortened esophagus or of a para-esophageal hernia. The end of the esophagus was not in its normal position fixed below the diaphragm but has ascended or is able to ascend as a hernia through the dilated hiatus. To determine questions of operability and the best manner of operation it is desirable to determine from the roentgen examination any evidence of development of adhesions in the hernial sac, a question which the roentgenologist is forced to leave unanswered quite frequently. Only when a case is encountered in which the contents of the hernial sac have completely emptied during observation can one express a definite opinion regarding the absence of adhesions.

Clinical. Pain in the epigastrium or its immediate neighborhood was complained of in 16 of the 24 cases in this series; burning or pressure sensations in the same region occurred in 3 cases. The pains were generally felt on the ingestion of food, sometimes immediately after swallowing, at other times up to two or three hours after a meal. In 2 of the cases the pains were clearly influenced by change of position. Vomiting occurred in 10 of the cases and eructation with acid fluid or heart burn

occurred in another 6 cases. Vomiting of blood or pronounced bleeding on instrumental examination occurred in 2 or 3 cases. Dysphagia was present in 4 cases and constipation in 5. Cardiac and pulmonary symptoms were present in 4 cases, the symptoms showing a periodicity in 10 cases and marked fluctuations in 4. Two of the latter and a third patient were characterized by an acute onset of the symptoms.

The symptoms outlined above were found to be generally similar to those reported in the literature. In only a relatively few of all the cases reported was there present any other disease condition that might be regarded as possibly responsible for the symptoms. On the other hand, these symptoms can be easily explained as the direct or indirect results of the hernia. It therefore seems highly probable that the chief symptoms in most of the cases were caused by the hiatus hernia subsequently discovered.

Medical treatment is recommended in those cases unsuitable for surgical interference. Medical treatment involves such things as suitable nourishment, the use of mild laxatives to prevent strain during defecation, which might tend to increase intraabdominal pressure.

Surgical. Operation for this class of cases is clearly indicated in the event of strangulation or when the symptoms are severe. When there are only mild symptoms or none at all operation should, in the absence of contraindications, still be advised in view of the risk and danger of a strangulation and because under the latter circumstances the prognosis is very much worse after operation. In considering the different methods of operation for diaphragmatic hernia it is important to realize that although it is relatively easy usually to reach the hernia from the abdominal cavity, hernias situated in a dome of the diaphragm seem to be more easily dealt with by the transpleural route.

Before undertaking the operation it is of utmost importance to find out first of all from a careful roentgenological examination the form of the hernia and whether it is free. The type of hiatus hernia characterized by a congenitally shortened esophagus does not lend itself to surgical treatment. The transpleural route should be chosen in cases of strangulation or where there is reason to expect adherent structures or complications with an ulcer in that portion of the stomach or duodenum contained in the hernial sac. The free hernias are more easily operated on through the abdominal route than by way of the pleura, the chance of recurrence, however, being greater by the former than by the latter. When the abdominal route is followed one must try to interrupt the communication between the peritoneal cavity and the hernial sac and whenever possible to obliterate the latter. In the case of free hernias one is able to decide only after a wide experience which method of operation should be chosen as most advantageous. If while operating by the abdominal route, it should prove impossible to replace the contents although a strangulation is not present, a future operation by the transpleural route must be undertaken, preferably postponed for a considerable time.

The 24 cases in this series are described briefly and an extensive bibliography is appended.

ARMANI, LODOVICO. Roentgen study of 180 gastroenterostomies. *Arch. di. radiol.*, Sept.–Oct., 1926, ii, 906–933.

The roentgen study made by the author of 180 cases in which gastroenterostomy had been performed shows that the opening does not atrophy nor close at any period after the operation. If it does it is because new lesions develop, such as ulcer, adhesions or neoplasm or because lesions that already exist have extended, as may happen in cases of neoplasm. His cases were examined from a minimum of fifteen days to a maximum of thirty-five years after the operation. The best emptying time of the stomach in the patients who had had gastroenterostomy performed, that is, the one found in patients who had no symptoms, was from two to four hours after the administration of the contrast medium. Gastroenterostomy alone is not sufficient in all gastroduodenal lesions, but sometimes in cases of diverticular ulcer, operable tumor or old gastrectasia or gastroptosis it must be associated with other operations, which have to be determined in each individual case. The best place to make the opening is at the lowest point in the stomach near the pylorus. A roentgen examination should be given before a gastroenterostomy to establish the indications accurately and another about two months after the operation when the conditions will have become about as they will remain permanently. There must be close collaboration between clinician, surgeon and roentgenologist both before and after operation.

BATTISTA, S. G. Clinical and roentgen study of a case of scoliosis from Pott's disease. *Arch. di radiol.*, Nov.–Dec., 1926, ii, 1003–1013.

The necessity of roentgen as well as clinical examination in diseases of the spinal column is shown by the case described. The patient was a boy of thirteen whose mother had noticed a deformity of the thorax. Clinical examination showed a lumbar scoliosis convex to the left, but there were none of the usual signs of Pott's disease such as pain, rigidity or cold abscess. But roentgen examination in addition to a

true scoliosis showed an angular deviation of the lumbar column caused by flattening of the right half of the second disc and the body of the third lumbar vertebra and decalcification of all the lumbar segment. The second and third vertebrae showed irregular atrophy of the bone, with indistinct and eroded outlines. The space between them was greatly reduced and very opaque and there was a trace of reactive proliferation. The scoliosis could be partially but not entirely reduced by having the patient lie on his back. This and the roentgen picture indicated a Pott's scoliosis, latent or perhaps cured, with a fibrous ankylosis in the course of becoming ossified. Another roentgen examination a year later showed a cold abscess originating from the vertebral lesion, thus confirming the former diagnosis of Pott's disease.

Bernstein, Arnold. On arthritis deformans of the costo-transverse joint. *Arch. f. klin. Chir.*, 1926, cxli, 419–439.

Alterations in the costo-transverse joint assuming the form of arthritic dentations represent a frequent finding in the region of the lung apical field in thoracic roentgenograms. They may lead to error by their resemblance to pulmonary foci. These arthritic dentations occur mostly at the heads of the ribs. At the end of each costo-transverse process is to be found a discrete ossifying bone nucleus which might lead to the suspicion of arthritic change.

Arthritis deformans may occur in the costo-transverse joint without the accompaniment of clinical symptoms. In the majority of cases, however, symptoms are present which suggest an inflammatory rheumatic origin. The type of certain of these symptoms (stabbing pains in the back and between the shoulder blades) first suggests some form of pulmonary disease. The roentgen examination reveals the true condition. The localization in the costo-transverse joints recalls the disease picture of spondylarthritis ankylopoetica. An examination of a case of this disease discloses that arthritis deformans of the costo-transverse junction actually can be demonstrated there. The cases cited by the author appear to be of rheumatic inflammatory origin similar to polyarthritis rheumatica. In one case in addition to the arthritic dentations in the apical pulmonary field there were also present peculiar shadows on both sides of the whole length of the thoracic spine which were interpreted as ossifications of the ligamenta capituli costae radiata. It is assumed in this case that the primary inflammatory process in the small joints which in its nature and etiology is closely related to spondylarthritis ankylopoetica can develop secondarily to the arthritis deformans of the costo-transverse joints.

There is a frequent occurrence of arthritis deformans of the costo-transverse joint in scoliosis of the spine. The joints on the concave side of the scoliosis were found to be the sites of election. This observation is explained as due to the abnormal static strain placed on the small joints on that side. Scoliosis by itself does not cause the changes described. A primary inflammatory process in these joints is a prerequisite for the development of the arthritis.

Blaustein, Nathan. Cystography an invaluable aid and advanced method of diagnosis of tuberculosis of the genito-urinary system. *J. Urol.*, May, 1927, xvii, 469–486.

A brief preliminary discussion is given on cystographic studies of direct pathological conditions of the bladder or as influenced by pathological conditions elsewhere in the genito-urinary system, with special emphasis on tuberculous uropathies. Emphasis is laid on the necessity of cystography as a routine procedure in the diagnosis of certain types of disease of the upper urinary tract.

In tuberculous lesions, whether affecting kidney, ureter or bladder, singly or collectively, the cystogram will reveal a pathology of the bladder never so graphically demonstrated heretofore. The pathological entity is so unique and conclusive that it constitutes a diagnostic certainty. A cystogram demonstrates a splinting of the bladder wall on the affected side; whether the lesion is in the kidney, ureter or bladder the pathological picture is the same. A 2 per cent or a 2.5 per cent solution of sodium iodide gives considerable detail to the cystographic film. The musculature of the bladder wall on the affected side is in a high degree of spasm and instead of the globular roughness seen in the normal bladder there is a sharp flatness beginning at the dome and ending at the base. This condition is called by the author "incline bladder." "Incline bladder" can be efficiently demonstrated in the cystogram by the use of weak sodium iodide solutions.

Castronovo, Ettore. True right diaphragmatic hernia of the stomach through the esophageal hiatus. *Radiol. med.*, March, 1927, xiv, 211–219.

A young man of twenty was admitted to the hospital with a diagnosis of ulcer of the stomach. Roentgen examination showed a right hernia of the stomach through the esophageal hiatus. There was a large diverticular sac in the right half of the thorax formed by a part of

the stomach which communicated with the abdominal part of the organ by a narrow neck which passed through the esophageal opening. The most interesting feature of the case was the position of the cardia which had followed the progressive distention of the wall of the stomach until it emptied into the neck of the hernia. If the case had gone on it would probably have continued to migrate until it was intrathoracic. The cardia was functioning normally. The hernia, which in all probability had a sac, was acquired, but not traumatic, as there was no history of trauma.

DELAHAYE, A. Anatomical cure of tuberculous osteitis. *J. de radiol. et d'électrol.*, Feb., 1927, xi, 81–88.

Normal reconstruction of bone is the test of anatomical cure in tuberculous osteitis. By means of roentgenography it is possible to follow up this cure step by step. The author gives histories and series of roentgenograms of 6 cases showing the gradual restoration of normal bone. It is important to preserve the whole periosteal sheath if possible to aid in the reconstruction of the bone. There are occasional cases in which such anatomical cure can be brought about by general and local treatment. One such case is described. These are cases of mild tuberculous osteitis treated from the beginning in which there are no sequestra or fungosities. Three of the cases described are ones of juxta-articular tuberculosis. Such lesions if not treated extend to the joint and cause serious complications. But if they are treated early, while the lesions are sufficiently limited, by curettage of the cavities filled with sequestra and fungosities, anatomical and clinical cure can be brought about without involvement of the joint. Such results as those shown here should be the rule and not the exception if proper treatment is given at the right time.

GIONGO, FRANCO. A case of bilateral coracoclavicular joint. *Radiol. med.*, March, 1927, xiv, 186–191.

A coracoclavicular joint is an anomaly that is rarely found in the cadaver and practically never in the living subject unless a trauma of the region calls the attention of the roentgenologist to the deltoid-pectoral triangle. It consists of a partial ossification of the trapezoid and conoid ligaments, the upper parts of which are changed into a large articular process, the coracoid process of the clavicle, while the rough surface which serves for their coracoid insertion is changed into a small slightly convex joint surface. In this way the normal syndesmosis at a distance is changed into an enarthrosis, the anthropological significance of which is not clear.

The author's case was in a woman of thirty-six who was admitted to the hospital for an injury of the right shoulder. The coracoclavicular joint was bilateral and was the only anomaly presented by the patient. There was no history of similar anomalies in the family and no tuberculosis taint. The anomalous joint had not had any effect on the injury for which the patient was admitted. The author thinks this anomaly would be found more frequently if a search were made for it. In studying it he recommends a caudo-ventro-dorsal projection with the tube centered on the tip of the coracoid process and strongly inclined from below upward.

GOALWIN, HARRY A. Some of the newer methods of the *x*-ray examination of the paranasal sinuses, optic canals, the pharynx and larynx. *Laryngoscope*, 1926, xxxvi, 235–256.

The complete roentgen examination of the sinuses requires at least 7 roentgenograms: the lateral, posteroanterior, cephalo-dorsoventral, caudo-dorsoventral, axial, right and left optic canals. Each sinus has a normal illumination which depends upon its depth, the density and thickness of its own walls and those of the skull. Before deciding upon the condition of a sinus the normal illumination to be expected should be estimated. To make this estimate possible, a full lateral and full posteroanterior view should be taken. The position of the head should always be measured by measuring the inclination of its particular planes to the roentgen plate, using a protractor. In case of doubt the illumination of the sinus should be measured by means of some form of photometer.

The roentgenologist should be thoroughly familiar with all the clinical and roentgenological aspects of the disease and the deformities of the head and needless to say with the finest details of the anatomy of the head. Great precaution is necessary in the roentgenography of the optic canals. The size of the focal spot of the tube should be measured. The distance of the focal spot from the plate and of the plate from the canal should be noted. The size of the optic canal cannot be taken directly from the film. It must be calculated. The roentgenologist's duty does not end when he makes a diagnosis. He should furnish the clinician with all the anatomical data he can determine from his roentgenograms which will help in treatment or operation.

Goalwin, Harry A. The clinical value of optic canal roentgenograms. *Arch. Ophth.*, 1926, lv, 1–20.

An optic canal roentgenogram is indicated in the following groups of cases: (1) optic neuritis, choked discs, retrobulbar neuritis, optic nerve atrophy, etc.; (2) sphenoidal disease with or without optic nerve symptoms; (3) orbital, ocular or optic nerve tumors; (4) known or suspected fracture of the skull, recent or healed; (5) foreign body in the orbit; (6) skull deformities with visual disturbances; (7) tumors of anterior or middle fossa; (8) certain general diseases like Paget's, acromegaly or rickets; (9) tuberculosis with optic nerve symptoms; (10) medicolegal cases where compensation is claimed for loss of sight alleged to have been caused by injury.

A systematic and complete analysis of optic canal changes consists of the following determinations: (1) shape of the cross section of the optic canal; (2) determinations of the cross section; (3) length of the canal; (4) changes within the lumen; (5) structure of the walls; (6) changes in adjacent structures. Fifteen cases are briefly described to illustrate nearly all of the types of cases in which optic canal roentgenography is of value.

Grégoire, Raymond; Béclère, Claude, and Darbois. Roentgen diagnosis in gynecology. *J. de radiol. et d'électrol.*, Jan., 1927, xi, 1–23.

This is a discussion of the indications, technique and results of roentgen diagnosis of gynecological diseases by means of the injection of lipiodol. The authors find that the intrauterine injection of lipiodol performed under strictly aseptic conditions and with a measured and constant pressure of 30 cm. mercury is entirely harmless and even if some lipiodol passes into the peritoneal cavity, it does not do any damage. This method of gynecological diagnosis has given very valuable results. It is indicated in the diagnosis of tumors of the pelvis, in metrorrhagia and in demonstrating the permeability of the tubes. The final diagnosis must be based on a combination of the clinical and roentgenoscopic findings and a study of the simple or stereoscopic roentgenograms made from in front and from the side. In fibroma there is generally a very characteristic picture of an enlarged and more or less deformed uterine cavity. In a few rare cases where the cavity is normal or decreased in size the passage of a lead wire around the tumor aids in the diagnosis. In case of cysts the picture of the uterus is generally normal, the tubes are often permeable and there is a lateral tumor. A great degree of deviation of the tubes suggests an intraligamentary tumor. In tumors of the tubes the picture shows the tube obliterated at the site of the tumor and more or less distended in front of it by the injection. If the tube is permeable it shows that it is normal.

In metrorrhagia there may be a lacunar intra-uterine picture or a change in the outline of the cavity. This shows the exact site of the lesion and an exploratory excision may then be made which will show whether it is due to retained placenta, polyp or a tumor of the body of the uterus. Roentgen examination with lipiodol gives information in regard to the permeability of the tubes which cannot be obtained in any other way. It shows whether each of the tubes is permeable and if one or the other is occluded it shows the exact site of the obstruction and enables the surgeon to perform a plastic operation to restore permeability. This exactness in diagnosis cannot be obtained unless a measured and constant pressure is used.

The article is profusely illustrated with roentgenograms and the following article by G. Cotte and Pierre Bertrand on pages 24 to 29 of the same journal consists entirely of 24 roentgenograms of the uterus and tubes after injection of lipiodol with legends beneath them describing the nature of the case and the roentgen findings.

Guleke. The transformation of transplanted bones in the roentgenogram. *Arch. f. klin. Chir.*, 1926, cxli, 325–344.

The study involves pseudarthrosis and bone defects of the radius and ulna produced by gunshot wounds in soldiers. The author made the bone transplants, and the cases all healed by primary intention so that the matter of infection is eliminated. These cases were re-examined five to ten years later, and all showed a solid healing of the bone, perfect function, which permitted the patients to engage in all sorts of heavy labor and athletic activities. The group included individuals between the ages of twenty-two and forty years.

The roentgenographic studies indicate that the transformation of the bone transplants and the restoration of the original bone shape in the arm occurs most completely in the lower portion of the radius and in the upper portion of the ulna, whereas the weaker, less important sections of the bone from the standpoint of function are much less satisfactorily restored.

Mandl, F. Clinical and experimental observations upon the problem of localized and generalized osteitis fibrosa. *Arch. f. klin. Chir.*, 1926, cxliii, 1–46; 245–284.

The differences between the localized and generalized types of osteitis fibrosa are discussed, especially the relation of the general form with the epithelial bodies. These two types are entirely different from the etiological standpoint. Recent researches make it probable that the local form is probably the result of marrow hematomas. The generalized form seems related more closely to rickets and osteomalacia and is very closely related to disturbances of the endocrine system. These differences are also apparent clinically from the standpoint of etiology, symptomatology, prognosis and therapy.

The partial or complete involvement of a single bone or the involvement of two adjacent bones at the site of contact may be classed under the heading of localized osteitis fibrosa. When the disease shows involvement of two or more bones not in contact with each other or of two bones in contact but involved in their entire extent the condition comes under the classification of generalized osteitis fibrosa. This distinction is made despite the fact that anatomically the two conditions cannot be distinguished from each other. A number of cases are described in detail and in certain instances the differential diagnosis from sarcoma on the basis of histological examination during operation was rendered very difficult because the osteitis fibrosa attacks every bone in the skeleton.

An attempt was made to cause a delay in marrow regeneration in rachitic animals. This attempt was unsuccessful. Trauma and washing out of the marrow failed to produce a pathological picture resembling osteitis fibrosa. On the other hand, the retardation of the clotting time of the blood by means of citrate injections appears to produce the desired result. From this it may be stated at least that retardation of clotting following trauma is a contributory cause to the formation of bone cysts.

Mosher, Harris P. False lung abscess and lipiodol. *Laryngoscope*, Feb., 1927, xxxvii, 138.

This is a preliminary notice calling attention to the drawback connected with the use of excessive amounts of lipiodol. So many apparent lung abscesses have been found in the cases referred from the thoracic service of the Massachusetts General Hospital to the throat department for diagnosis, bronchoscopy and the injection of lipiodol that the suspicion has been growing that the shadow which so perfectly simulated an abscess in most areas was an area of ' drowned lung," that is drowned in lipiodol. Experiments on dogs have proved this suspicion to be correct. They showed that 40 per cent lipiodol injected into the terminal bronchus of a normal lung will give a picture of a lung abscess. In order therefore not to draw false conclusions weaker solutions of lipiodol must be used. It is felt that the oil if it is to be of service must be introduced with a nebulizer.

Mosher, Harris P., MacMillan, Alexander S., and Motley, Frederic E. A clinical and preoperative study of the thymus in children of the tonsil and adenoid age. *Laryngoscope*, 1926, xxxvi, 1–30.

A series of 4,820 roentgenograms shows that – per cent of children in the tonsil and adenoid age (from two to sixteen years) have an enlarged thymus. The statement that 50 per cent of children have enlarged tuberculous glands which give a broad mediastinal shadow indistinguishable from the shadow given by an enlarged thymus is not correct. A series of 90 roentgenograms taken at a tuberculosis sanatorium showed a broad mediastinal shadow in – per cent. A study was made of the roentgenological aspects of the problem and it was found that the crying of a child during the taking of the roentgenogram does not enlarge the size of the thymus. Blood counts made on children shown by the roentgenogram to have an enlarged thymus gave a slight lymphocytosis but it was not enough to be diagnostic. There was no change in the blood count after roentgen therapy of the thymus. Comparing percussion with the roentgen ray as a means of finding an enlarged thymus, percussion was successful in 25 per cent of the cases submitted to both methods of examination. In status lymphaticus the thymus is enlarged along with the enlargement of the lymphoid tissue of the alimentary tract (Peyer's patches), the solitary follicles and the mesenteric glands. A thymic death is remarkably like a death from acidosis.

Since an enlarged thymus is the only available hint that a generalized enlargement of the lymphatic structures of the alimentary tract may also exist, since this is the only pathological finding at autopsy in status lymphaticus, since deaths from status lymphaticus are more commonly associated with tonsil and adenoid operation, it seems a wise precaution in the present state of our knowledge to learn the size of the thymus and if it is enlarged to reduce it to normal size by the therapeutic use of roentgen rays before undertaking the tonsil and adenoid operation, in fact, before performing any surgical operation on infants and children.

Pazzi, Ermanno. Roentgen study of polycystic kidney. *Arch. di radiol.*, Sept.–Oct., 1926, ii, 944–950.

In a former article on the subject Pazzi reported that he believed that the pyelogram of polycystic kidney generally showed elongation of the calyces. He has since made a further study of the subject and presents in this article the histories of 3 cases in different stages of the disease. He now believes that there is no uniform pyelographic picture of polycystic kidney. As cystic degeneration of the kidney is a disease with a slowly progressive course the pyelographic picture will vary depending on the stage of the disease. In an early stage the pyelogram will show elongation of the calyces, and in a more advanced stage when the calyces are more seriously affected they will be shortened and even obliterated as in tumor. The only way to make a roentgen differential diagnosis between tumor and polycystic kidney is to make a bilateral pyelogram, as bilateral tumor of the kidney is exceptional and unilateral polycystic kidney is very rare.

Piccinino, Guido. Cholecystography. *Arch. di radiol.*, Jan.–Feb., 1927, iii, 154–183.

Among the signs that have been utilized heretofore in the roentgen study of the bile tract, aside from direct visibility of calculi, which is found in a relatively low percentage of cases, some, such as visibility of the gallbladder and its imprint on the stomach or duodenum must be interpreted with caution. Little or no importance can be attributed to functional signs on the part of the stomach or duodenum as they are common to many abdominal diseases. Deviations and malformations of the stomach, duodenum and hepatic angle of the colon as a result of adhesions from inflammatory processes are of great importance but often difficult to demonstrate.

While cholecystography is of considerable importance in the diagnosis of diseases of the bile tract it generally shows only functional changes, but in the majority of cases does not show the anatomical lesion that has caused them. It is not a method of examination that can be used alone; its results are of value only when considered in connection with those of other methods of examination, particularly examination of the digestive tract, which in many cases supplements the defects in the results of examination by the method of Graham and Cole.

Pincherle, Pino. Sacroileitis. *Radiol. med.*, March, 1927, xiv, 153–167.

The author proposes giving the name of sacroileitis to inflammatory lesions of the sacroiliac joint, adding if possible the adjective which will show what the nature of the process is, such as tuberculous, oesteomyelitic, syphilitic, gonorrheal. He devotes a chapter to each of these groups. There are four different forms of tuberculous sacroileitis: (1) The beginning type with a small focus near the synchondrosis; (2) the chronic type with dry caries; there is a destructive focus in the joint space which is usually circumscribed with sclerotic and tortuous edges; (3) the chronic type with abscess formation which is more extensive than the preceding one with localized ankyloses and formation of small sequestra; (4) the synovial type like that which occurs in other joints; there is no sclerosis; there may be localized or gravity abscesses. Tuberculous sacroileitis is the most frequent form of the disease.

Physicians have been calling tuberculous disease of this joint sacrocoxalgia in Italy and France and sacrocoxitis in Germany. But these names are not correct because the symptoms are not at all those of coxalgia and the hip joint is always intact.

The author also discusses syphilis of the sacroiliac joint and osteomyelitis from pyogenic cocci. In osteomyelitis there are large foci, acute atrophy and larger and thicker sequestra than in tuberculosis. In syphilis there are serious changes with sequestra on both sides and a very evident periosteal reaction. It is probable that bilaterality is a characteristic feature of syphilis while tuberculosis affects only the joint on one side.

In the chapter on differential diagnosis the author discusses tumor and arthritis deformans, describing and illustrating with roentgenograms the different changes in the joint and interarticular line. These changes may simulate those of sacroileitis or sacralization, sciatica or lumbago. The clinical symptoms are grouped so that with the aid of the roentgenogram a differential diagnosis can be made between sacroileitis and any of the other diseases mentioned above.

Ryan, E. J. The use of opaque substances to localize a lung abscess. *Laryngoscope*, 1926, xxxvi, 674–675.

The opaque substances most used have been the salts of bismuth, either (1) as a powder insufflation or (2) suspended in some medium, commonly olive oil. More recently iodized oil preparations have found favor and at present are most widely used. With bismuth insufflation of the lungs the author has been most unsuccessful, the dry powder outlining only the main branches into which it is blown for a short

distance and outlining cavities very imperfectly when compared with the fluid media. The bismuth in oil, usually a 40 per cent mixture has been found to work out excellently. It is sufficiently fluid to find its way into the smaller bronchi and the smallest amount is enough to give a sharply defined shadow on the roentgenogram. Lipiodol is more fluid than the suspension of bismuth in oil and therefore more searching in the smaller bronchi and into cavities where the lumen of the bronchus is narrowed by inflammatory thickening of the membrane.

Sessa, Piero, and Porta, Remo. Roentgen study of the gall-bladder by means of cholecystography. *Radiol. med.*, March, 1927, xiv, 192–218.

The authors describe 20 cases in which they practiced cholecystography by the various methods, intravenous, oral and by proctoclysis. They find the method simple, valuable and absolutely harmless. They find that the normal gall-bladder should be visible 8 to 24 hours after the injection. It should be oval or pyriform with its greatest diameter along the longitudinal axis of the body; it may be more or less dense, but always homogeneous, not lacunar; its outlines should be distinct and regular. Its site may vary somewhat with the habitus and position of the patient and the degree of meteorism, but it should lie in the right paravertebral line between the transverse processes of the first to fourth lumbar vertebrae. A gall-bladder that does not conform to this picture is pathological. It may be changed in form by inflammation of the gall-bladder, new-growths or abscesses of the liver, or adhesions to the pylorus, duodenum or colon. Superimposition of the colon on the gall-bladder does not always indicate adhesions; the roentgenogram should be repeated with compression to separate the shadows of the two viscera; if there are no adhesions their outlines will be clear and distinct but if there are adhesions the gall-bladder shadow will be deformed. The site of the gall-bladder may be changed by new-growths, adhesions, exaggerated meteorism or ptosis of the liver. It may be enlarged by hydrops of the gall-bladder or stenosis of the common duct; it may be decreased by inflammation, neoplasm or more rarely by spasm of the gall-bladder. Lacunar filling almost always indicates calculosis. In some cases lack of homogeneous filling may be due to defective irrigation with the contrast fluid of an enlarged gall-bladder not entirely emptied of bile. The same thing may happen from defective concentration of the bile from inflammation or neoplastic infiltration of the walls of the gall-bladder. If the gall-bladder does not show it may be due to obstruction of the cystic duct by inflammation or calculus or kink from adhesions. These conditions may be temporary so several examinations should be made at intervals. Defective filling of the gall-bladder may also be due to defective liver function or acute or chronic inflammation of the intrahepatic bile ducts. A negative finding should not be considered absolutely decisive as it may be due to various errors of technique.

Vallebona, A. Special methods of roentgen examination of the stomach. *Radiol. med.*, April, 1927, xiv, 300–317.

The author reviews the methods of examination of the stomach which have been used to study the mucosa of the stomach in greater detail than is possible by the ordinary Rieder method. He first takes up the methods in which only small quantities of opaque medium are introduced into the stomach, particularly Rendich's technique. Then he describes Bastruup's methods, setting forth all their advantages and disadvantages. He then takes up his own method and refers for the technique to his former articles. It is a combined method in which the wall of the stomach is covered with a thin layer of opaque substance and the stomach insufflated. His method is absolutely without danger.

He makes a comparison of these different methods. Rendich's method is useful in studying the mucous folds of the stomach with its walls collapsed, but if the fine irregularities of the stomach mucous membrane are to be examined it is better to dilate the stomach and the author's method is therefore the best one for studying gastritis, for these small mamellated irregularities which correspond to areas in the mucous membrane in which the gastric glands are more developed than elsewhere, are very prominent in chronic hypertrophic gastritis while they are only slightly developed in the atrophic form so that the mucous membrane looks smooth. These irregularities do not disappear even when the stomach is greatly distended. These fine irregularities of the gastric mucosa are entirely independent of the mucous folds.

Special attention is given to the pyloroduodenal region, in the examination of which Vallebona's method is particularly useful. Its advantages are that the walls of the stomach can be studied more thoroughly than by the usual method, peristalsis can be studied more completely and more accurately, the pyloroduodenal eminence which is sometimes hidden by contrast medium in the ordinary method can be seen through the walls of the stomach

and a more complete examination of the pyloroduodenal region made and the structure of the mucous surface can be studied in more detail.

ROENTGEN AND RADIUM THERAPY

Béclère, A. The dangers to be avoided in roentgen therapy of the craniospinal cavity. *J. de radiol. et d'électrol.*, Dec., 1926, x, 556–563.

With increasing use of deep therapy for tumors of the brain and spinal column the effectiveness of roentgen treatment has increased but there has been a corresponding increase in its danger.

When the skin is given an erythema dose the true reaction does not occur until after an interval of about two weeks but there is an immediate reaction within an hour after the irradiation, consisting of dilatation of the capillaries and edema. This prereaction may occur in deep organs as well as in the skin. When this edematous swelling takes place in an organ situated in a rigid cavity, as are the brain and spinal column, it may lead to serious consequences. If the reaction is very intense it may cause trophic disturbances resembling those of section of the spinal cord, followed by death from septicemia in a few weeks. If the reaction is less intense there may be only disturbances of motion and sensation, followed by progressive improvement or even complete cure of the tumor. Cases illustrative of these different degrees of lesion are described. The intensity of the accidents does not depend so much on the radiosensitiveness of the tumor as on the size of the dose given and the degree of compression of the spinal column that has existed before the treatment was given. The more compression the tumor is exercising on the spinal cord, the greater the danger is from the prereaction and the more care must be exercised in treatment. In many of the cases published exact details as to the dosage are not given, but Béclère believes the first dose should not be more than 500 R and another should not be given for at least 48 hours, so as to avoid if possible even transitory symptoms of increased compression.

The objection has been made to small and frequently repeated doses that they stimulate the tumor cells and bring about a gradually increasing resistance of the tumor to irradiation. But the facts on which these theories are based are capable of different interpretations and Béclère does not believe that increased resistance to rays from repeated small doses has been proved. At any rate the first rule to be observed is not to do any harm by treatment.

Bergamini, Marco. Modern treatment of acute anterior poliomyelitis. *Arch. di radiol.*, Sept.–Oct., 1926, ii, 827–905.

In 1922 the author published the results of his first cases treated by the Bordier method of roentgen therapy, diathermia and electrotherapy and expressed a favorable opinion of the method. He now gives a detailed description of 10 cases which confirm his previous opinion. He used the Bordier method with only some slight modifications in detail and he thinks such modifications may be made advantageously, adapting the treatment to each case. The treatment has no bad effects and it is the best one available at present for this disease, even though it does not completely cure the paralysis in all cases. The author thinks it particularly important that its value be made known as there is a large group of physicians who say that treatment is hopeless in this disease and so nothing is done to prevent the late results which have such a devastating effect on the whole life of the patient. He cites a number of other works in the literature which also report good results from the method.

The critics of the method say that the results of the treatment are only apparent, that the treatment is given during the period when the disease is undergoing spontaneous retrogression and that this improvement is credited to the treatment. But the author argues that this period of spontaneous retrogression is only for a period of two to three weeks and that this is followed, in untreated cases, by permanent hypotrophy, hypothermia, decrease or abolition of electrical stimulability and paralysis in the groups of muscles corresponding to the injured cells. No one has ever seen a return to normal trophism and function after two to three months in an untreated case, such as is seen in cases treated by the Bordier method.

It has never been claimed that the Bordier treatment has a specific action on the virus of the disease. Its object is to further resolution and absorption of the inflammatory process and improve the chances of recovery of cells that have only been partially damaged. Therefore it must be given early before the damage is irreparable—that is, the roentgen-ray part must be given early and there is no question of the value of the later diathermic and electrical treatment. The use of the method does not prevent or interfere with the use of orthopedic methods if desired. It only puts the paralyzed limbs in the best condition to profit

by any further treatment that may be necessary.

CHIZZOLA, GIULIANO. Modern treatment of acute anterior poliomyelitis with roentgen therapy, diathermy and electrotherapy. *Radiol. med.*, March, 1927, xiv, 168–185.

The author used Bordier's treatment for acute anterior poliomyelitis during the severe epidemic of 1924–1926 in Venice. He does not give the technique of Bordier's use of roentgen rays but merely refers to the work of that author for details. The roentgen treatment should be begun as soon as possible, the first series of irradiations being given the first week after the febrile period. The acute inflammation first affects the vessels and the edema, hemorrhage and distention and thrombosis of the vessels are important factors in causing the later serious lesions in the gray matter of the anterior horns of the cord. Roentgen therapy does not act directly on the virus of poliomyelitis and probably not directly on nerve tissue, but on the blood vessels, inhibiting edema, small cell infiltration and proliferation of connective tissue. In this way it acts indirectly on the motor cells of the cord, preventing further damage and allowing of restoration of cells that have not been completely destroyed. The roentgen rays act in this way on the spinal lesions and diathermy and electrotherapy are used later for the muscle paralyses. Heat applied in other ways only raises external temperature while the high frequency diathermic current raises the temperature within the tissues to normal or slightly above. It should not be raised higher than that, particularly in young children, for harm has been done in some cases by too high a temperature. The author finds that the effect of diathermy is permanent and in some cases there seems to have been a cumulative action. He gives 10 or 12 treatments to a series instead of the 5 or 6 recommended by Bordier, and every day instead of every other day. Each treatment lasts twenty minutes. The author believes that diathermy should be begun soon after roentgen therapy, without waiting for hypothermia and dystrophy to begin. Diathermy is particularly valuable in those cases in which there is pain in the paralyzed limbs.

Electrotherapy is valuable in the late treatment of the paralyzed muscles. The base of the electrical treatment is the continuous galvanic current. It is best not to use electricity until the inflammation has subsided as it may irritate the inflamed spinal column. The author does not use more than 4–5 ma. for 20 minutes. For the first year he gives a series of 20 daily treatments followed by a rest of 1½ to 2 months. Later he gives a period of treatment of 3 or 4 weeks followed by 2 or 3 months of rest. Brief applications (3–5 minutes) of a sinusoidal current may also be given to stimulate the smooth muscles of the vessels. The electrical treatments should be continued for a long time until the paralyzed muscles are restored to normal or as nearly so as possible.

He has used this combined method in 62 cases with complete cure in 23, almost complete cure in 11, very great improvement in 10, slight improvement in 9 and practically no improvement in 9. The latter were very serious cases and the treatment was incomplete. He does not agree with those authors who believe that the disease is less serious now than it was in the epidemics of 1905 and 1908.

DEL BUONO, PIETRO. The method of choice in the treatment of neuralgia of the trifacial. *Arch. di radiol.*, Jan.–Feb., 1927, iii, 184–200.

The author reports his results in the treatment of 19 cases of trifacial neuralgia by a combination of roentgen rays and diathermy. He gives the diathermy first, followed by roentgen irradiation. For the diathermy he places the electrodes on the two temporal regions and applies heat to a small surface for 30–40 minutes. His technique for roentgen irradiation is the use of hard rays, but not above 150 kv., with a filter of 0.5 mm. copper; the focal distance is not less than 40 cm. and the rays are applied to a small field in the temporal region. Each treatment is for 10 minutes and in stubborn cases 5 to 6 treatments may be given on the same field. In some cases after 6 to 7 treatments on the one side he continued the treatment with the same technique on the other side until the pain stopped.

Among the 19 cases 7 had been treated previously by resection or peripheral alcohol injection. The roentgen and diathermy treatment was unsuccessful in these cases. Among the other 11 it was successful in 8, or 72.8 per cent. Three cases were treated by diathermy alone and all of them were unsuccessful. All the cures have persisted for one to four years. He counts as unsuccessful 2 cases which were relieved of pain for nine months and then the neuralgia recurred. His results after surgical treatment agree with those of other authors who report that roentgen treatment is ineffective after surgical treatment.

He concludes that the results of mild surgical treatment such as alcoholization and resection of peripheral branches are temporary and still these methods subject the patient to the dan-

gers of surgical operation. Better results and ones that are generally permanent are obtained by resection of the Gasserian ganglion, alcoholization of the ganglion and retrogasserian alcoholization. But these are serious operations which endanger life and the function of neighboring organs—the ear, eye and mouth. In view of the good results of combined diathermy and roentgen treatment and its absolute harmlessness he thinks it should be tried in all cases of trifacial neuralgia in which the ordinary medical treatments have not been successful. If two or more series of irradiations do not cure the condition, the patient should be sent to the surgeon, but operation should not be performed before roentgen treatment, as if it fails it interferes with the success of the latter.

Del Buono, Pietro. Roentgen irradiation of the hypophysis in dysfunction of the uterus and ovaries. *Radiol. med.*, April, 1927, xiv, 292–300.

Del Buono discusses the clinical results obtained in cases of dysfunction of the uterus and ovaries which he treated by irradiation of the hypophysis. Among diseases due to defective function he had satisfactory and permanent results from irradiation of the hypophysis in primary and secondary amenorrhea, dysmenorrhea and syndromes due to defective ovarian function. Among diseases due to excess of ovarian function good and permanent results may be expected in hemorrhagic metropathies as well as in hemorrhages due to inflammation of the uterus, adnexa and ovaries.

Des Barres, A. Le Roy, and Heymann, P. Cancer of the penis at Tonkin. *J. de radiol. et d'électrol.*, Feb., 1927, xi, 89–100.

Cancer of the penis is very frequent at Tonkin, constituting about 17.5 per cent of all cancers. There are two forms, the vegetating with large cauliflower masses, and the ulcerating. They are generally not noticed in the beginning because of phimosis, and the patient does not come for treatment until there is a purulent discharge and swelling of the end of the penis. At the end of three or four years or sometimes more the cancer invades the scrotum, lower part of the abdomen and internal surfaces of the thighs. Difficulty in micturition may cause dilatation of the bladder and the urethra may rupture at points where its wall is infiltrated.

The authors have recently treated 13 cases, histories and illustrations of 10 of which are given. All of the cases were in an advanced stage. They treat by operation or radium or both. Surgical treatment consists of total removal of the penis. There is a difference of opinion as to whether the inguinal glands should be removed but as the authors have often found them free of invasion they do not remove them unless they are clinically involved. They have had excellent results from radium treatment. They curette or cauterize exuberant masses so there will be as little absorption of cancer tissue as possible. They then put radium needles containing 1 to 2 mg. radium with 0.5 mm. filter in the substance of the tumor, the number depending on its size. Generally they give doses of 15 to 20 mc. in eight to ten days. They do not believe in the large doses of 50 mc. recommended by Ferrari. They used such doses at first but found that they caused such induration of the tissues that secondary amputation was necessary. Their patients were discharged with the tumor cured or greatly improved but the time has not been long enough so that they can say whether the results will be permanent.

Gouin, J., and Bienvenue, A. Roentgen therapy of the sympathetic in dermatoses. *J. de radiol. et d'électrol.*, March, 1927, xi, 129–143.

Since 1919 the authors have been practicing roentgen irradiation of the sympathetic in certain dermatoses and endocrine disorders. They use distant action of rays filtered only a little or not at all and also deep irradiation. In lichen planus they use a superficial method which they call sympathetic and a deep one called spinal.

They find that in the majority of dermatoses the pruritus is greatly ameliorated by roentgen treatment. The results are sometimes inconstant in eczema, prurigo, diffuse neurodermatitis, parakeratosis, etc., and paradoxical in certain cases of zona and urticaria. The skin eruption also disappears but, as for pruritus and in the same dermatoses, there are inconstant or paradoxical reactions. Roentgen therapy of the sympathetic generally has no effect on the eruption in psoriasis and trophic dermatoses, congenital or otherwise. In some cases the roentgen treatment is sufficient without any other therapy, but in some dermatoses it should be combined with the usual local, general and dietetic treatment. The elimination of the pruritus makes it possible to cure the eruption sooner by local measures.

In general diseases such as alopecia and Basedow's disease superficial dorsal roentgen therapy does not have any effect. A slightly filtered roentgen therapy with a special localization for these diseases is being studied. Both superficial and deep roentgen therapy have failed in asthma. In Hebra's prurigo good

results have been obtained but care must be taken to avoid harmful reactions. Lower dorsolumbar roentgen therapy is effective in ovarian disturbances such as metrorrhagia, dysmenorrhea and amenorrhea if they are purely superficial; it stops metrorrhagia and brings on menstruation in cases of functional defect. Sympathetic roentgen therapy has given complete success in lichen planus. As in the other dermatoses unless there is some contraindication it is applied in the upper dorsolumbar field. One treatment is generally sufficient. If this treatment fails the lower field may be tried. In buccal lichen planus the rays should be only lightly filtered—not more than 2 mm. aluminum. In buccal lichen planus without a cutaneous eruption superficial or semi-filtered roentgen therapy may bring on a skin eruption. Sympathetic roentgen therapy with the typical localization does not cause any appreciable skin or general reaction. The authors prefer the sympathetic to the spinal method because its results are more constant, there is no reaction and the technique is simple. A study of the neurovegetative condition of the patient is necessary before any roentgen treatment, either sympathetic or spinal.

If the patient is in a condition of neurovegetative instability there may be general reactions; there is particularly apt to be asthma in pruritus. Semi-filtered irradiation on the lower field may cause symptoms resembling those of roentgen sickness; the same thing may also occur in irradiation of the upper field and in spinal irradiation.

It does not require a large dose to cause roentgen sickness. The neurovegetative instability of the patient is one of the causes of this syndrome. Irradiation of the lumbar field is another and perhaps also direct irradiation of the hypogastric and splanchnic plexuses. Moderate filtration and moderate dosage are indicated in such cases. Irradiation of special localizations such as the superior ganglion in alopecia and the stellate ganglion in Basedow's disease may cause reactions. The symptoms are sympathetic symptoms, such as pruritus, erythema, vasomotor disturbances, disturbances of nasopharyngeal, salivary and sweat secretion, ocular symptoms, disturbances of intestinal movements and thyroid and ovarian reactions.

The authors realize that their study is fragmentary but publish it in the hope that it may be continued by others.

GUARINI, CARLO. Five years of roentgen treatment of cancer. *Arch. di radiol.*, Nov.–Dec., 1926, ii, 983–994.

At the Institute of photo-radiotherapy in Naples, of which Guarini is director about 1600 cases of cancer have been treated between January, 1922 and July, 1926. In an institution of that size every effort is made to adopt a uniform technique so far as possible. They use a transformer apparatus with closed circuit and Coolidge tube with a spark gap of not less than 36 or more than 40 cm. The best potential is from 2–3 milliamperes. For deep therapy he finds that it is best to administer a skin erythema dose in not less than 20 minutes at 23 cm. distance with a filter of $\frac{1}{2}$ mm. zinc and 3–4 mm. aluminum; he finds small fields 6 × 8 cm. best in cancer of the uterus. For cancer of the cervix he uses 6 to 7 fields, depending on the size of the pelvis and the amount of fat. He has treated 6 operable cases of epithelioma of the cervix and has had no further information in regard to two. Four are clinically cured after periods varying from a year and a half to five years.

He does not believe it is always necessary to have the same wave length as he has used spark gaps of from 36 to 41 cm. with currents of 2 to 4 ma. and therefore wave lengths of 0.4 to 0.7 Å without any serious bad effects. He has had 15 per cent clinical cures in his cases of inoperable cancer of the uterus. Roentgen treatment should not be given in cases of severe cachexia, cases in which there is generalized infection or extensive metastasis, particularly in the lungs and liver, and cases which have been previously treated without knowing the nature of the treatment so as to judge of the radiosensitiveness of the tumor. Cases with an ichorous local discharge should not be treated without previous disinfection. About 20 per cent of the cases of carcinoma of the uterus admitted to the Institute were not adapted for roentgen treatment.

In cancer of the breast he has the best results with large fields with a cathode skin distance of 70–80 cm. He irradiates the whole breast and a large area of normal skin around it and the axillary, supraclavicular, subclavicular and lateral neck glands, protecting other skin areas. He generally gives 7 or 8 treatments one a day, then every other day and finally every 3d or 4th day until the first signs of erythema appear, which usually requires 10–14 hours of irradiation. In five years he has treated about 90 cases of carcinoma of the breast, 15 after operation and 75 without operation; he has had later reports from only 20 of the latter. There has been no recurrence in any of the cases operated on and then irradiated in a period of from one to five years. He has not heard of any recurrences in the ones treated by irradiation alone if they were treated in an early stage without adenopathy; some of these

cases were treated as long as four years ago. In some cases of very large tumor with invasion of the glands the tumors were reduced sufficiently to be operable. In cases of ulcerated tumor there was cure of the ulcerations, reduction of the tumor and disappearance of the adenopathy. Scirrhous cancer of the breast is the form that reacts best to treatment. His statistics for cancer of the breast are about the same as those reported by Wintz in 1925. In some cases he has practiced roentgen castration in treating cancer of the breast and finds that it improves the results.

In cancer of the tongue he uses 4 fields 6 × 8 concentrated on the tongue. The normal ray is directed in such a way as to form an angle of 35°–50° with the plane passing through the tongue; he tries to make the normal ray converge on the zone invaded by the neoplasm. If there are metastases which cannot be concentrated on he uses distant fields. The cases treated in this way are too few and the time is too short to be able to judge of permanent results. But he believes that it gives better results than other methods. As a general thing the results in epithelioma of the tongue are not brilliant. The tumor is generally arrested and reduced in size but recurrence is very frequent. He has one case treated by diathermo-coagulation and roentgen irradiation that has remained cured for two years. About 50 per cent of the patients with cancer of the tongue have syphilis, but antisyphilitic treatment does not have any effect on the cancer.

He treats epitheliomas of the skin by Ghirladucci's method of variable filtration except that he does not use iontophoresis and has made slight changes in the use of the various filters. He has also had excellent results with electrocoagulation followed by variable filtration. He has had about 80 per cent of permanent cures in epithelioma of the skin.

Pomeroy, Lawrence A., and Strauss, Abraham. Radium in diseases of the eye, ear, nose and throat. *Laryngoscope*, 1926, xxxvi, 437–444.

Brief review is given of the particular diseases of the eye, ear, nose and throat in which radium has been found of value, and a comparison is made of this method of treatment with other methods. An accurate diagnosis is absolutely essential before undertaking the treatment. There is need of coöperation between the radium therapist and the specialist in diseases of the eye, ear, nose and throat.

Robinson, G. Allen. Radium therapy in diseases of the eye and adnexa. *Arch. Ophth.*, 1926, lv, 328–337.

Radium is the treatment of choice in angiomas, vernal conjunctivitis, epidermoid carcinoma of the eyelids and early carcinoma of the bulb. Radium is indicated as a postoperative measure in primary intra-ocular tumors, and should be given first choice in primary orbital tumors. Careful methods of irradiation and close coöperation between radiologist and ophthalmologist are necessary to determine the status of radium in diseases of the eye and adnexa. Five illustrative cases are cited and pictured.

The author has observed 2 cases of cataracts following the use of large doses of radium. One patient, a girl aged six years, had been treated for a sarcoma of the left lower eyelid five years previously; and 3000 mg-hr. gamma radiation in two applications were applied to the orbit at a distance of 3 cm. Vision had become blurred and the lens opaque three years after treatment. There was also loss of the eyebrows and eyelashes and a marked atrophy of the skin of the lids. The lens was removed. There was good light perception and projection and the fundus appeared normal. The other patient was a middle-aged woman who had a severe diabetes mellitus and had been treated four years before for an epidermoid carcinoma of the right upper lid. In addition to the cataract a secondary glaucoma developed and the eye had to be enucleated. Young children cannot tolerate maximum doses of radium any more than other forms of medication. Diabetes may have been a metabolic factor in the second case.

Sabbadini, Dario. Roentgen-ray lesions in the human eye. *Arch. di radiol.*, Sept.–Oct., 1926, ii, 795–826.

The experimental work on the subject is reviewed and the author then describes 3 clinical cases in which large doses of roentgen rays were applied to the eye. He finds that a dose of from 150 to 200 per cent skin erythema dose causes serious injuries of the human eye. There are lesions of the conjunctiva and cornea probably due to direct necrotic action of the rays on the epithelial cells. Secondary to this there is a marked infiltration of the bulbar conjunctiva and cornea and also of the anterior part of the sclera. Parallel with these changes there are lesions in the uvea directly due to the rays, first in the ciliary processes, then in the iris and choroid. The ganglion cells of the retina are affected early by the necrotic action of the rays and an ascending atrophy of the optic nerve is secondary to the injury of these cells. All the vessels of the eyeball show to a greater or less extent a degenerative process of the walls which Hirschfeld calls vacuolar

degeneration. The lesions found by Hirschfeld and Jacoby in the eyes of rabbits are also found in the human eye, though histological examination, particularly in the author's third case, shows a more marked involvement of the ciliary body in the human eye than in the rabbit.

SCHOENBERG, MARK J. Report on a case of bilateral glioma of the retina, cured in the non-enucleated eye by radium treatment. *Arch. Ophth.*, May, 1927, lvi, 221–228.

A report is given of the first case on record of bilateral glioma of the retina treated by radium and observed for ten years, in which useful vision was recovered. A cataract which developed during this time was successfully removed. The child, a girl aged two, came under the author's observation in 1916 and showed a typical glioma of the retina of the left eye. The left eye was enucleated and a careful examination of the right eye showed two sharply circumscribed, grayish white tumors of the retina. The right eye received radium emanation treatment, 36 mc. with lead filter applied to the right temple for four hours. The second treatment was given five months later, consisting of 58 mc. held over the eye for eight hours at a distance of 1 cm., the rays being filtered through lead. Two years later a third radium treatment was given, consisting of 200 mc. over the right side of the orbit for 14 1/2 hours, filtered through 2 mm. lead plus 0.5 mm. silver.

SORDELLO, ATTILI. Roentgen treatment of gonorrheal arthritis. *Arch. di radiol.*, Nov.–Dec., 1926, ii, 995–1002.

Six case histories are given. The author finds that gonorrheal arthritis both in the acute and chronic stages responds very quickly to roentgen treatment. Patients 1 and 2 had been in the hospital for months and had all sorts of treatments; the joints were very painful and their function greatly reduced. A single series of irradiations relieved the pain and restored function to such an extent that the patients were able to leave the hospital and go to work. One patient was at the height of the disease and no treatment had been given. A single series of treatments relieved pain and restored function.

The treatment was very simple. The author used an Apex apparatus, 2 ma., 12–20 cm. spark gap, 23 cm. skin distance, filter 1 mm. aluminum, three or four fields, giving altogether a deep dose of 15–20 per cent of a skin erythema dose. Excellent results are obtained by this treatment alone but it does not contraindicate the use of other methods of therapy also, such as vaccine and protein therapy. A combination of diathermy and roentgen therapy is effective in chronic cases.

The rays have little if any direct effect on the gonococci. They act indirectly either by increasing the defensive forces of the cells or by producing antitoxins and bacteriolysins by their action on the bacteria. They also have a good effect on the electrical processes of the body fluids and in this way facilitate the fixation of blood calcium by the bones. The theory of an indirect action is still further supported by one of the author's cases in which irradiation of one joint had a good effect on other joints which were not subjected directly to the action of the rays.

INVERNIZZI, G. Theory and practice of roentgen therapy with special reference to the blood. *Arch. di patol. e clin. med.*, 1927, v, 288–320; 616–652.

This is an exhaustive review of the whole subject of roentgen treatment of blood diseases and the indirect effects on the blood of irradiation in general diseases. The conflicting reports of various authors in the treatment of a long series of blood diseases are reviewed. The treatment, for the most part, has been purely empirical and the attempted explanations as well as the clinical results are contradictory. It may be considered as established that irradiation of the blood-forming organs causes an immediate temporary hypoleucocytosis which begins soon after a short irradiation or during a prolonged one and is probably a sign of a disequilibrium in the humors of the body brought about by destruction of tissue by the rays. This is accompanied by other phenomena of an anaphylactic nature such as changes in the coagulability of the blood, the number of blood platelets, eosinophilia, lowering of the refractometric index of the plasma, decreased alkalinity of the blood and of the chlorids of the plasma. The red cells do not undergo any change in this phase. This is followed by a secondary leucocytosis of longer duration characterized by absolute and relative lymphopenia and granulocytosis with deviation to the left of Arneth's formula and entrance of young immature cells into the circulation. This is accompanied by hyperactivity of myeloid tissue due not so much to direct stimulating action of the rays as to indirect stimulation by the products of leucolysis which brings about a true renewal of the cells in the circulation, erythrocytes as well as

leucocytes. This is followed by a secondary progressive leucopenia which is greater the larger the dose of rays. This leucopenia is accompanied by regressive phenomena in lymphoid and myeloid tissue. It is due to increased destruction and inhibited new-formation of leucocytes. At the same time there may be decrease in the number of erythrocytes from decreased formation or increased destruction, the latter only in the blood-destroying organs, for if the destruction were brought about in the circulation it would be accompanied by hemoglobinemia and hemoglobinuria which does not follow irradiation. It is still a question whether the hemoglobin is transformed into bile pigment by the liver cells or by the reticulo-endothelial cells. These changes are quite different from those caused by ordinary light rays.

It also seems established that very small amounts of rays have a stimulating action on living tissue. Stimulation is preceded by a latent period which is in inverse proportion to the radiosensitiveness of the cells and the dose administered. Any harmful action is preceded by a stage of stimulation, the length of which is in inverse proportion to the radiosensitiveness of the cells and the amount of rays. There is no specific radiosensitiveness that is constant for a given normal or pathological tissue, so that it is impossible to standardize the dosage.

The empirical use of the rays in various diseases has brought about a change in the theories as to the mechanism of their action. The destruction of granulomas is now thought to be due not so much to direct destruction as to mesenchymal stimulation and complex phenomena which increase the defensive powers of the body. Both the destructive and stimulating actions of the rays produce biochemical changes in the cells and plasma. An index of the physicochemical changes in the blood and particularly of the degree of dispersion and stability of the colloids is furnished by the rapidity of sedimentation of the erythrocytes. A study of sedimentation shows, however, that the physicochemical changes in the blood after irradiation are not constant but depend on the individual, the region irradiated and the nature of the irradiation. The edema and exanthemata which are seen in anaphylactic phenomena after irradiation are also the results of biochemical changes in the humors.

Experiments have shown that the coagulability of the blood is increased when very vascular parts of the body are irradiated. The reports on the effect of irradiation on metabolism are contradictory.

Jouguénbourg, Anna. Radiotherapy of diseases of the bone marrow. *Ann. de roentgenol. et radiol.*, 1927, ii, 204–210.

In polycythemia there is a hyperplasia of the bone marrow, particularly the erythroblastic cells. Aplastic anemia is a disease diametrically opposed to polycythemia. It is not a special form of anemia but an advanced stage of any anemia after the bone marrow has lost its capacity for regeneration.

The author describes a case of each of these diseases in which good results were obtained by irradiation. The first case was a typical one of polycythemia in a woman aged fifty-seven who had presented the symptoms of the disease for the past seven years. Roentgen rays were applied to the spinal column, the ribs, the feet and legs and the lower third of the thighs. The patient was given 5 erythema doses. The dose for each field was 75–100 per cent erythema dose. For the first two weeks after the irradiation there was an increase of the pain in the legs and the spinal column; the patient could hardly walk and became fatigued very easily. These symptoms disappeared gradually and the composition of the blood improved. At the end of six months she came back to continue the treatment. She felt well, was working hard as a physician, her skin had lost its purple color, her eye grounds were normal and the composition of the blood almost normal. There was a slight leucopenia, the viscosity of the blood had decreased and its coagulability had increased.

The second patient was also a woman of fifty-seven with an aplastic anemia from nosebleed. She had had habitual nosebleed since childhood without any apparent cause. It was an unusual case of hemophilia in a woman and she had transmitted the disease to her two daughters. Irradiation of the spleen increased the coagulability of the blood and the hemorrhage became less profuse, particularly for the first few days after a treatment. During this time there was a slight improvement in the composition of the blood. Application of roentgen rays not only to the long bones but also to the scapulae, sternum, ribs and calvicles caused another increase in hemoglobin and erythrocytes and a decided improvement in the patient's general condition. Radium was also placed in the patient's nose to bring about cicatrization of the excoriations. During the first few days after the radium treatment the coagulability of the blood increased considerably, the hemorrhage at first became more frequent and then stopped entirely in a few days. During this period there was a very great increase in hemoglobin and erythrocytes; the composi-

tion of the blood became almost normal but coagulability still remained considerably below normal.

It seems paradoxical that radiotherapy was equally effective in these two opposite diseases but it is quite possible to obtain opposite effects in radiotherapy by acting on opposite endocrine glands. There is every reason to suppose that polycythemia and hemophilia are endocrine disturbances.

Rochlin, D. G., Schirmunsky, Claudia, and Kotschneff, Nina. The pathogenesis of psoriasis and the first results of roentgen irradiation of the hypophysis. *Ann. de roentgenol. et radiol.*, 1927, ii, 236–239.

In 1925 the authors reported that in the roentgenograms of the majority of patients with psoriasis they found the measurements of the sella turcica at the highest level of the normal. There was a very massive perpendicular sella, probably due to a constitutional peculiarity. Most patients with psoriasis, independently of their sex and the nature of their work, showed an acromegaloid structure of the bones of the extremities after twenty-five years.

They have now treated 26 patients with psoriasis by roentgen irradiation. In 6 patients the thymus was irradiated. In 1 girl ten years of age the eruption disappeared almost completely. The treatment had no effect in the other cases. Of the 20 patients who were treated by irradiation of the hypophysis 4 withdrew from treatment prematurely, leaving 6 women and 10 men. There was considerable improvement in 1 of the women, little or none in the other 5. But these 5 showed deviations from normal in the sex glands, so the disease was perhaps due to ovarian rather than hypophyseal dysfunction. Among the men there was no improvement in 4, in 3 there was more or less decrease of the eruption and in the other 3 almost complete absorption of the eruption all over the body. One of these patients was forty years old and had had psoriasis for thirty-six years. The skin was left smooth with only a little pigmentation. These results have persisted six to seven months. The eruption in most cases began to disappear on the 7th to 14th day; in 1 case on the 4th. There were no bad effects in any of the cases. Blood sugar is generally decreased in psoriasis. After irradiation of the hypophysis in these patients blood sugar increased, no matter whether the psoriasis was improved or not.

Scaduto, G. Roentgen epilation of the arms of women with hypertrichosis. *Radiol. med.*, July, 1927, xiv, 591–592.

The author has had excellent and permanent results with this method, better in mature women of twenty-four years or more than in younger ones. The results are also better in plump arms as the papillae are stretched and react better to the rays. Three positions are used. In the first the patient is seated with her forearm resting on a sandbag about 50 cm. long which supports the hand also. The dorsal surface to be irradiated is divided into 3 zones, and the normal ray is directed successively on the center of each. The patient leans as heavily as possible on the sand bag so as to flatten out the zone to be irradiated. The second position, which is palmar and slightly oblique inward, also includes three zones. In the third position the patient leans her elbow on the sand bag and flexes the forearm on the arm, resting her hand on the deltoid region of the same side. This gives 9 fields which cover the area to be irradiated; if there are any spots that have escaped irradiation they can be retouched later. The technique and dosage are the same as those the author uses for the face and have been described in a previous article.

Sordello, Attili. Late results of roentgen treatment of Heine-Medin's disease. *Arch. di radiol.*, Jan.–Feb., 1927, iii, 213–217.

Sordello gives brief histories of 9 cases of paralysis following acute anterior poliomyelitis. These are the only cases he has been able to follow up for several years, making electrical tests of the muscles, showing that the results are permanent. He used Ghilarducci's method of roentgen treatment. He concludes from these 9 cases that the results of roentgen irradiation in Heine-Medin's disease are superior to those of any other method of treatment and that complete clinical cure may be accomplished by it. The effects are better the earlier the treatment is begun. If the treatment is begun more than a month after the beginning of the paralysis the results are not so good and this shows that it is the roentgen treatment which brings about the improvement in these cases and that it is not simply a question of spontaneous improvement. It does not seem to be necessary to combine the roentgen treatment with diathermy of the groups of muscles affected.

Zanotti, Guido. Radium therapy of epitheliomas. *Radiol. med.*, July, 1927, xiv, 584–591.

Five cases of epithelioma treated by radium therapy are reported. The results so far have been very satisfactory; the tumors disappeared and there has been complete cicatrization, but as the cases were all treated during the year

1926 it is impossible as yet to say what the final outcome will be. The lesions were shown by histological examination to be cancerous. Two of the cases had been operated upon and the tumors had recurred in a little while. In the other 3 cases the site or extent of the lesions was such that surgical treatment did not seem to be very hopeful.

The author used doses varying from 26.7 to 72 mc. applied over a period varying from seven to eighteen days; he based the amount of irradiation on a study of the histological type of the tumor and the number of mitoses. He believes that a careful study of the number of karyokineses is very important in determining the duration of treatment, but he thinks it is not possible to get an exact karyokinetic index for a tumor because it is impossible to make extensive and complete enough histological observation in the different parts of it. Though in 2 of the cases the tumor was implanted on a bleeding bone surface as a result of the preceding surgical operation and in the other 3 they were near to bones no radium necrosis of the bones occurred. The author is convinced that radium necrosis of bone can be prevented by using high filtration and a good secondary filter like those recommended by Proust and Nabias, by observing the strictest asepsis in the application of the tubes and dressings so as to prevent secondary infection and by prolonging the length of the application and decreasing its intensity so as to avoid too rapid liquefaction of the tumor and too massive irradiation of the bones.

MISCELLANEOUS

Abraham, Adolf. The intensity distribution of roentgen-ray energy inside and outside the ray cone under various conditions of operation. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1926, xxxiv, 908–919.

These observations embracing a portion of the Holfelder program include: (*a*) a study of the intensity distribution inside and outside the cone by photographic measurements, and (*b*) a study of the effect of various operating conditions on the nature and shape of the central ray curve as determined iontometrically.

The photometric studies were made on duplitized Agfa films which were hung in various positions and then irradiated under all possible variations of operation. All the exposures were found to show, independent of the applied wave length and other operating conditions that (*a*) the cone of rays maintains its sharpness to great depths; (*b*) the peripheral ray of the cone forms a sharp boundary between the shadow and the ray; (*c*) the scattered ray mantle outside the cone of radiation is pear-shaped and possesses very slight energy values; (*d*) the intensity from the middle of the cone to the periphery does not suffer any important decrease. The photographic observations show distinctly that under the various conditions of operation, the fundamental type of intensity distribution remains unaltered and a quantitative change is produced only in the depth effect of the beam of rays. The photographic method is found to be very suitable for the study of intensity distribution because by this method no disturbing substances are present in the water phantom and the individual measuring elements are the grains in the photographic film.

The iontometric measurements were made with a Siemens roentgen dosimeter, the small chamber of the first model being employed. The course of the curve in the central ray was carefully studied, both for hard and soft radiations. It was found that the intensity curve had a hump, depending on the voltage and field size, in the first 2 to 3 cm. and then pursued a steep linear decrease.

Bonanno, M. The erythrocyte formula in roentgen therapy. *Arch. di radiol.*, Nov.–Dec., 1926, ii, 1014–1032.

Experiments on guinea pigs showed that large doses of roentgen rays caused a deviation to the left of the erythrocyte formula; that is, a decided relative increase in microcytes with a considerable decrease in the total number of red cells. One guinea pig was killed by the large dose while another lost weight rapidly. In another series of guinea pigs treated with much smaller doses there was a relative increase in the large forms with only a slight decrease in the total number of erythrocytes.

Three clinical cases are described, one of carcinoma of the breast which had been operated upon, one of tumor of the testicle and one of lymphogranuloma, in which roentgen treatment was given and the roentgen formula followed up. There was a deviation to the right of the formula as the condition of the patients improved, showing regeneration with increased activity of the bone marrow. Another group of cases is described in which in spite of roentgen treatment the clinical condition of the patients continued to grow worse and one of the patients died a month and a half after the treatment. In this group there was a deviation of the formula to the left with increase in the relative number of microcytes and moderate decrease in the total number of erythrocytes. In roentgen treatment of a case of pernicious

anemia there was an increase of the deviation to the right which already existed before the treatment, showing an exaggeration of the characteristic property which the bone marrow has in this disease of discharging into the circulation erythrocytes of an embryonic type.

Broglio, Ruggero. Experimental denervation of the kidney and pyelography in series. *Arch. di radiol.*, Sept.–Oct., 1926, ii, 934–938.

A series of 6 pyelograms was made of each of 3 dogs, one with both kidneys normal, one in which both kidneys had been denervated and one with one normal and one denervated kidney. Legueu has recently shown by means of pyelograms that the kidney pelvis and ureter have movements comparable to intestinal peristalsis and the author studied these movements in the normal and in denervated kidneys. Papin has recently proposed denervation of the kidney in painful renal diseases. The pyelograms showed that the peristaltic wave of the kidney pelvis was much slower and less effective in the denervated kidneys than in the normal ones. The normal kidney pelvis emptied in ten to fifteen minutes while there were still traces of opaque liquid in the denervated pelvis after an hour. The capacity of the denervated pelvis was less; the animal showed signs of intolerance after the injection of 1 c.c. liquid into the denervated pelvis and not until after 3 c.c. in the normal one. After three hours the denervated kidney was almost double the size of the normal one and the parenchyma showed intense congestion. When the nerves are cut the muscles that contract the pelvis become inert and the pelvis does not fulfill its function of expelling the urine which accumulates and causes distention. The author concludes that denervation is an operation the severity of which is out of proportion to the good accomplished, particularly as the same purpose can be accomplished without affecting the function of the organ by sectioning the rami communicantes of the sympathetic which transmit sensation.

Pyeloscopy and particularly pyelography in series are excellent methods of studying the evacuation of the kidney pelvis in infections and hydronephrosis, in which variations in contractility are of great value in prognosis. They are also valuable in establishing the indications for treatment in retention, as conservative operation would be perfectly useless in a case in which contractility is completely lost, while it would be very effective in cases in which contractility is preserved or only slightly damaged.

Moscariello, A. Note on the experimental use of polonium in the human body. *Radiol. med.*, April, 1927, xiv, 317–325.

Basing his work on the animal experiments of Lacassagne, Lattès and Lavedan and making use of polonium furnished him by Mme. Curie, Moscariello experimented with this substance in 3 cases, one of carcinoma of the liver, one of calculosis of the liver and one of epithelioma of the right orbit. He gave the solution subcutaneously in fractional and very small doses (60 skin unit doses in all in 6 days). His results were not encouraging and he concludes that with the present state of knowledge of the nature and biochemical action of polonium it should not be used in man, considering the serious changes that it brings about in the blood-forming organs and the kidneys even when given in very small doses. The authors mentioned above think its action is due to the alpha rays of polonium but Moscariello thinks it is due rather to some unknown toxic property of polonium.

Mosher, Harry P. X-ray study of movements of the tongue, epiglottis and hyoid bone in swallowing, followed by discussion of difficulty in swallowing caused by retropharyngeal diverticulum, postcricoid webs and exostoses of cervical vertebrae. *Laryngoscope*, April, 1927, xxxvii, 235–262.

The observations on swallowing were made with barium milk sometimes thickened with bread. No observations were made with a thick bolus of food like meat. All the roentgenograms were taken by Dr. MacMillan. The series of roentgenograms of the tongue, the epiglottis and the hyoid bone were made on the roentgenologist himself in order to secure maximum intelligent coöperation. The records of the movements of the tongue, epiglottis and the hyoid bone in swallowing were subsequently used in the study of 2 cases of bulbar paralysis.

Knowledge of the fact that exostoses of the cervical vertebrae may be responsible for difficulty in swallowing has been confirmed by the author in several new cases. This can be demonstrated only by a careful roentgenological examination. The knowledge of the existence of these exostoses is necessary for a safe examination of the lesions at the mouth of the esophagus. The presence or absence of exostoses should be noted before an examination of the esophagus is attempted with rigid tubes.

Palmieri, G. G. The laws of absorption of roentgen rays. *Radiol. med.*, April, 1927, xiv, 268–292.

If a body 10 cm. thick is irradiated and the

intensity of the irradiation at a given point A on its surface and the intensity at a depth of 10 cm. from this point measured the intensity will be found to have decreased. This decrease is due to divergence of the rays and absorption. The decrease due to divergence can be calculated according to the law of the square of the distance and the value for the coefficient of divergence found. Physically the decrease due to absorption is dependent on two factors—fluorescence and diffusion. The physical laws and mathematical formulae for calculating these factors are given.

Pugno-Vanoni, Enzo. Absorption of roentgen rays and Compton effect. *Radiol. med.*, March, 1927, xiv, 208–211.

Up until recently it was thought that secondary irradiation had the same wave length as the primary rays. Compton concluded that this was not exactly true and found that secondary irradiation in different directions has a wave length that increases as the angle between the primary ray and the secondary irradiation increases. Mathematical formulae for calculating the wave length of secondary irradiation are given. The practical deductions from this fact are that in using a large field for deep therapy the increase in the deep dosage from secondary irradiation is not from waves of the same wave length as the incident ray but from longer waves, the length increasing as the field is enlarged; that the theoretical calculation of the energy absorbed in the deep tissues is more complicated than has been thought because of the various zones of secondary wave length. There is a greater quantity of energy absorbed than has been calculated, as the diffuse radiation is less penetrating than has been assumed. Even if the hypothesis of a specific action for different wave lengths is admitted rays of uniform length could not be used practically as different lengths would appear in the secondary irradiation. The production of a Compton effect in filters does not greatly change the action ordinarily attributed to the rays because they are nearly always metals with a high atomic weight in which the phenomenon is less intense and they are used in thicknesses and at angles which practically nullify the effect.

Franco, Pietro Maria. Potential physical test of the thyroid in relation to potential physical test of the suprarenals in pulmonary tuberculosis. *Arch. di radiol.*, Jan.-Feb., 1927, iii, 201–212.

The author tested thyroid function by giving 5 per cent and the suprarenals by giving 10 per cent of an erythema dose at each irradiation. Three irradiations were given the thyroid and three the suprarenals on alternate days. The effects of the suprarenal irradiation were studied by noting whether there was increased, unchanged or decreased secretion; adrenalin was determined in the blood and urine. The effects of the irradiation on the thyroid were determined by observation of nitrogen and mineral metabolism, and the effect of thyroid function on the cardiovascular system, the vegetative nervous system and the blood. The research was extremely long and laborious and the study of endocrine relations is very intricate so that the problems involved are by no means settled yet. He found that in general thyroid hypofunction is accompanied by suprarenal hyperfunction and thyroid hyperfunction by suprarenal hypofunction. The previous studies of metabolism in tuberculosis have generally shown that metabolism is accelerated. The author's method of studying the thyroid-suprarenal system shows that each patient with tuberculosis has a special metabolism which depends on the condition of the thyroid and this condition of the thyroid is correlated with that of the suprarenals. Thirty-two tables are given showing the details of the examinations.

Gassoul, R. The effect of roentgen rays on living tissues *in vitro*. *Ann. de roentgenol. et radiol.*, 1927, ii, 211–225.

Details of the method of experimentation and the lengths of time the cells were exposed to the rays are given. The experiments seem to show that the rays have a direct action on the protoplasm and its inclusions. This seems to be confirmed by the fact that the vibrations of the epithelium at first become stronger and then feebler until they stop completely. The contractile substance of the cilia of vibratile epithelium appears to be closely related to the basal bodies of the cells which, with the mitochondria of the protoplasm form an organic and functional unit. Other authors have demonstrated the extreme sensitiveness and lability of these cells to roentgen rays. The changes in the reducing properties of the epithelium under the influence of the rays was directly dependent on changes in their vibratory function and also intimately related to the biochemical properties of the living substance of the protoplasm.

The author concludes that the rays directly or indirectly brought about either a rupture of celloidal equilibrium or some other lesion to which the tissue reacted with regeneration if the lesion was not too severe. The energy expended in regeneration is deducted from the total potential energy of the living object.

This is why an acceleration of the vibrations is followed by their premature cessation. The acceleration is brought about at the expense of duration. This is also seen in leucocytes, lymphoctyes and erythrocytes which die sooner if they are irradiated than if they are not. These results agree with the theory of Néménow and Nadson that under the influence of irradiation cells and organisms exhaust their vital energy more rapidly and grow old quicker.

Giovetti, Vittorio. Combined Potter-Bucky trochoscope. *Radiol. med.*, June, 1927, xiv, 483–485.

The author has found it very inconvenient to move the patient and adjust the bed for using the Potter-Bucky diaphragm after taking an ordinary roentgenogram. So he has devised a combined table by means of which this can be accomplished easily. The ordinary trochoscope bed is simply prolonged by a concave layer of aluminum 120 cm. long, the curvature being the same as that of the Potter-Bucky diaphragm. When the ordinary roentgenogram has been taken the patient can be slipped onto the curved aluminum bed without any difficulty. A sliding stand at the side of the bed makes it possible to center the diaphragm at any desired point. An illustration shows the details. The author has been using this table for some months and finds it simple and practical.

Liberson, J. G., and Vail, S. S. Experimental research on the effect of *x*-rays on protoplasm. *Ann. de roentgenol. et radiol.*, 1927, ii, 248–253.

The authors studied the protoplasm of the epithelium of kidney cells after irradiation by a special staining method. One kidney of the rabbit was irradiated, the other being carefully protected. The animals were killed from a few days to three weeks after the irradiations and the kidneys examined in the usual way—formalin fixation and staining with hematoxylin-eosin and the Giemsa method. Only kidneys were chosen for further examination in which the cells of the irradiated kidney could not be distinguished from those of the non-irradiated one; that is, they were in the latent stage. A further study was then made by their special method of the epithelial cells of the convoluted tubules of the irradiated kidney. The protoplasm of the normal kidney shows a number of rod-shaped structures, chiefly at the base of the cell perpendicular to the membrana propria. In 25 per cent of the kidneys both had the same appearance, but in the other 75 per cent the irradiated kidney showed granules instead of rods in the protoplasm. The nuclei were just like those of the non-irradiated cells. The cells looked much like the desquamated cells in the tubules of a normal kidney. In the further course of the process the granules became arranged in clumps, they stained more faintly and finally the same changes were seen as are seen in parenchymatous degeneration of kidney epithelium.

For purposes of comparison they studied the epithelial cells of the tails of tadpoles by vital staining with neutral red. The findings confirmed what they had found in the histological study of the epithelial cells of the kidney, namely that different cells and different parts of the same cell have varying degrees of sensitiveness to roentgen rays.

Nadson, G., and Jolkevitch, A. The combined action of radium and chemical agents on vegetation. *Ann. de roentgenol. et radiol.*, 1926, ii, 11–39.

Various chemical agents, such as iodin, potassium iodid and copper sulphate, chloral hydrate and eosin were introduced into plants, *Sinapis alba* being used as the plant for the experiments. It was found that they sensitized the plants to the action of radium. The combined action of these agents and radium caused a greater retardation in the development of the plants and greater pathological changes than either of the factors acting alone. The nature of these substances and their atoms is very different; their action is the same whether they are introduced into the plant before or after irradiation from which the authors conclude that the increase of the depressant effect on the growth of the plant is not due to the formation of secondary rays but to simple superposition of the depressant action of the factors. This also suggests that probably the increase in the effect of radium and roentgen rays in man after the introduction of colloidal metals is not due to the action of secondary rays, as assumed by the authors who have performed the experiments, but simply to a superposition of the effects of the different factors.

Certain experiments showed that the introduction of potassium iodid into the organism does not increase but enfeebles the effect of radium and may even nullify it entirely. It is evident that the potassium plays the part of antagonist to the radium, while the iodin increases the depression caused by it. This is a case of antagonism between potassium and radium analogous to that observed by Zwa-

ardemaker in his experiments on the isolated frog's heart. The anesthetic action of chloral hydrate considerably increases the depressant action of radium. The action of anesthetics evidently increases the sensitiveness of the organism to rays and the same thing is true of the animal organism. Experiments on the eggs of cyclops have shown that radium retards the development of the eggs much more if they have been subjected to the action of either beforehand and still more if they are subjected to it during the irradiation itself. The combined effect of radium and eosin has the same distinctly inhibiting action on the development of the plants as the combined action of daylight and eosin (photodynamic action). This too is a simple case of superposition of the effects of eosin and radium. As early as 1905 Werner showed that the injection of eosin under the skin of a rabbit sensitized it to the action of radium, and eosin also sensitizes mice to the action of ultraviolet rays.

By using the proper amount of the chemical agent, which must be determined in each case, the same effect can be obtained with a much lower dose of rays than if the sensitizer is not used. It will require further study to determine the balance between the sensitizing agents and the rays. The use of such sensitizers may prove important in radium and roentgen treatment and the experiments also show the necessity of taking into account certain facts which have not heretofore been sufficiently considered in giving roentgen or radium treatment, such as whether any medicines have been given that contain mineral salts, whether the patient has been subjected to any anesthetic substances, such as chloroform, chloral hydrate or alcohol and whether it is possible for sensitizers and desensitizers to form spontaneously in the tissues. The action of different kinds of rays on the human being is much more complex than is generally supposed. And all these factors must be taken into consideration before a really scientific radiotherapy can be given.

Nemenow, M. The biological action of roentgen rays. *Ann. de roentgenol. et radiol.*, 1926, ii, 1–10.

The author made a study of the affect of roentgen rays on Arneth's leucocyte formula and concludes from his work and that published in the literature that the action of roentgen rays brings about a rapid exhaustion of vital energy. It is the oldest cells that are most sensitive to roentgen rays. The age of the cell is determined by the proportion between the time it has already lived and the whole length of its existence. Karyokinesis is a manifestation of aging of the cell. The essential feature of the process which takes place inside the cell under the influence of roentgen rays and makes it grow old consists in a disturbance of metabolism and the accumulation inside the cell of the products of metabolism.

Panow, N. A. The effect of roentgen irradiation on blood pressure. *Ann. de roentgenol. et radiol.*, 1926, ii, 74–81.

A study was made of the effect of roentgen irradiation on blood pressure in 62 cases in which the changes in pressure could not be attributed to anything else but the irradiation. Although the majority of the patients were being treated for tumors the list includes cases without any visible disturbance of the heart or kidneys and without cachexia. Three of the patients had arteriosclerosis and were used for experimental purposes. The average systolic pressure was from 80 to 170 mm. mercury; 87 per cent of the patients were women and only 13 per cent men. The thoracic region was irradiated in 39 per cent of the cases, the abdomen in 51 per cent and the head and extremities in 10 per cent. Physical and psychic factors which might have affected the blood pressure were eliminated. Changes less than 10 mm. mercury were counted as lying within the limits of error and were not considered.

Systolic pressure was lowered in 68 per cent of the cases, raised in 10 per cent, and oscillated in both directions or did not show any great change in 22 per cent. The changes were generally from 10 to 30 mm. mercury; there were few changes of more than 30 mm. The greatest changes were in the cases with high pressure, the least changes in the ones with low pressure. As most of the author's cases had a moderate pressure the changes were not very great. The pressure curve after irradiation is by no means uniform. In some cases the total fall took place immediately after the irradiation, in some it took place gradually over a period of several hours. In cases of roentgen sickness the curve was very irregular. Most of the patients were irradiated every day. At the end of the twenty-four hours the pressure had generally returned to somewhere near normal, though not quite to normal. Three or four days after the end of the series the pressure had generally returned to normal.